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CONFIRMATION/QUALIFICATION STAGE 1 FOR ENGLAND AFB
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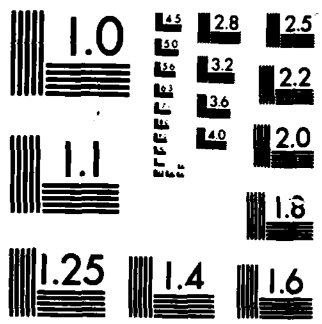

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AD-A165 044

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 1

FINAL REPORT

FOR

ENGLAND AFB, LOUISIANA

TACTICAL AIR COMMAND
LANGLEY AFB, VIRGINIA

PREPARED FOR

UNITED STATE AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (OEHL)
BROOKS AIR FORCE BASE, TEXAS 78235

NOVEMBER, 1985

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PREPARED BY

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CONTRACT NO. F33615-83-D-4001

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This report has been prepared for the U.S. Air Force by Radian Corporation for the purposes of aiding in the implementation of Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force or the Department of Defense.

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PREFACE

Radian Corporation is the contractor for the Installation Restoration Program (IRP) Phase II Stage 1 investigation at England AFB, Louisiana. Phase II Stage 1 tasks were conducted under USAF Contract No. F33615-83-D-4001, Delivery Order 10.

Soil and ground-water samples were collected from seven sites of potential contamination identified in the IRP Phase I Records Search. Samples were analyzed for oil and grease and volatile aromatic hydrocarbon compounds. Resulting data were used to determine: 1) if any of these sites are contaminated as a result of past waste management practices or fuel or other spills; and 2) what, if any, additional Phase II activities are needed to quantify the extent of contamination at specific sites.

Key Radian project personnel include:

Marshall F. Conover - Contract Administrator
Thomas W. Grimshaw - Program Manager
Debra L. Richmann - Project Director
Fred B. Blood - Field Sampling

Radian would like to acknowledge the cooperation of the England AFB Bioenvironmental Engineering Staff, and especially the assistance of Lt. Matthew Chini.

The work reported herein was accomplished between January 1984 and July 1984. Major Gerald D. Swoboda, Technical Services Division, USAF Occupational Environmental Health Laboratory (USAF OEHL) was the Technical Monitor. He was succeeded by Dr. John Yu and Captain Phillip Jung who served as Technical Monitors during review of the draft reports.

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SUMMARY

Background and Purpose

The Department of Defense (DOD) has developed the Installation Restoration Program (IRP) to identify, report and correct potential environmental deficiencies from past waste management activities that could result in ground-water contamination and probable migration of contaminants beyond DOD installation boundaries. The IRP is a four-phase program consisting of: Phase I, Problem Identification/Records Search, Phase II, Problem Confirmation and Quantification, Phase III, Technology Development, and Phase IV, Corrective Action. The Phase I study for England AFB, Alexandria, Louisiana has been completed and reported, ~~(Engineering-Science, 1983)~~. Presented in that report are descriptions of the installation and its environmental setting, a review of industrial operations and base support activities conducted at the base, an inventory of major solid and hazardous wastes from past activities, a review of past waste handling, treatment and disposal facilities, and an evaluation of the pollution potential of each identified site.

The site now occupied by England AFB was opened in 1942 as Alexandria Army Air Base. Until 1945, the facility was used as a bomber combat crew training school. Early in 1946, the base was placed on standby status and was eventully turned over to the City of Alexandria for use as a municipal airport. The base was reactivated as Alexandria Air Force Base in 1950. That same year, it was assigned to Tactical Air Command. In June 1955, the base was officially renamed England Air Force Base.

Since July 1972, the 23rd Tactical Fighter Wing (TFW) Tactical Air Command, has been the host unit on base. The 23rd TFW is currently equipped with the Fairchild Republic A-10 Thunderbolt II aircraft.

The 23rd Tactical Fighter Wing's mission is to maintain a combat ready posture capable of worldwide deployment to bases and forward operating locations with minimum support facilities. It conducts close air support,

joint anti-armor operations, battlefield interdiction, search and rescue missions, and employment of conventional munitions (including AGM-65 Maverick missiles) against surface targets. A total of fourteen major tenant organizations are located at England AFB.

In Phase I, 20 different sites were identified which may have contributed to environmental contamination. The activities creating these potential impacts date back to the 1940's and include general refuse disposal, landfilling of low-level radioactive and hazardous wastes, sludge weathering and spreading, spills and leaks, and storage and fire training areas. A listing of these sites is presented in priority-ranked order in Table 1.

For Phase II Stage 1 ~~Radian Corporation has~~ investigated ~~impacts to~~ the soils and ground water at selected waste disposal sites on England AFB. The purpose of this investigation was to determine if contamination has occurred from waste disposal practices, or from fuel or other spills. During Phase II Stage 1 activities, 33 soil borings were hand-augered at seven sites. A total of 96 soil samples were collected and analyzed for oil and grease by the infrared (IR) method (EPA Method 413.2). In addition, one ground-water sample was collected from each of the seven project sites and from each of three USGS monitor wells that tap the shallow alluvial aquifer. Each of these 10 ground-water samples was analyzed for oil and grease (EPA Method 413.2) and for volatile aromatic hydrocarbons (EPA Method 602).

Areas of Investigation

The 20 sites of potential contamination identified in Phase I included spills and leaks, fire training areas, land disposal areas, and areas used for a variety of other waste management practices. The Phase II Stage 1 study evaluated a total of seven sites (the six sites recommended for Phase II monitoring by the Phase I report and the site of a suspected MOGAS leak (SP-7) identified for Phase II study by England AFB personnel). Figure 1 shows the locations of the seven Phase II Stage 1 project sites.[1] Table 2 outlines the

[1] The location of SP-5 identified in the Phase I report is inaccurate according to England AFB personnel. The correct location of SP-5 is shown in Figure 1.

TABLE 1. PRIORITY RANKING OF POTENTIAL CONTAMINATION SOURCES, FROM IRP PHASE I, ENGLAND AFB (Engineering Science, 1983)

Rank	HARM Score	Site No.	Site Name	Date of Operation or Occurrence
1	61	FT-1	Fire Training Site No. 1	1940's-1964
2	58	D-15	POL Sludge Weathering Pit	1950's-1982
3	53	SP-4	JP-4 Underground Line Leak	1977-1978
4	53	SP-5	JP-4 Underground Line Leak	1981
5	53	FT-3	Fire Training Area No. 3	1966-1980
6	52	SP-3	JP-4 Underground Line Leak	1977-1978
7	52	SP-2	Tank 1319 JP-4 Spill	1969
8	52	S-1	Waste Oil Storage Tank	1965-mid 1970's
9	51	D-3	General Refuse Disposal Site	1950's
10	50	D-8	Chlorine Gas Cylinder Disposal Site	Early 1960's
11	50	D-10	Hazardous Chemical Burial Mound	1945-1946
12	49	S-6	Lake Charles Drum Storage Site	?-Present
13	48	FT-2	Fire Training Site No. 2	1964-1966
14	48	FT-4	Fire Training Site No. 4	1980-1982
15	48	D-4	General Refuse Disposal Site	Late 1950's-Early 1960's
16	48	D-5	General Refuse Disposal Site	Early 1960's-mid 1960's
17	46	SP-6	CE Tank Spill	1970's-1980's
18	46	SP-7	Motor Pool Underground Tank Leak	1976-1977
19	37	RD-1	Low-Level Radioactive Waste Disposal Site	1957-1958
20	35	RD-2	Low-Level Radioactive Waste Disposal Site	Unknown

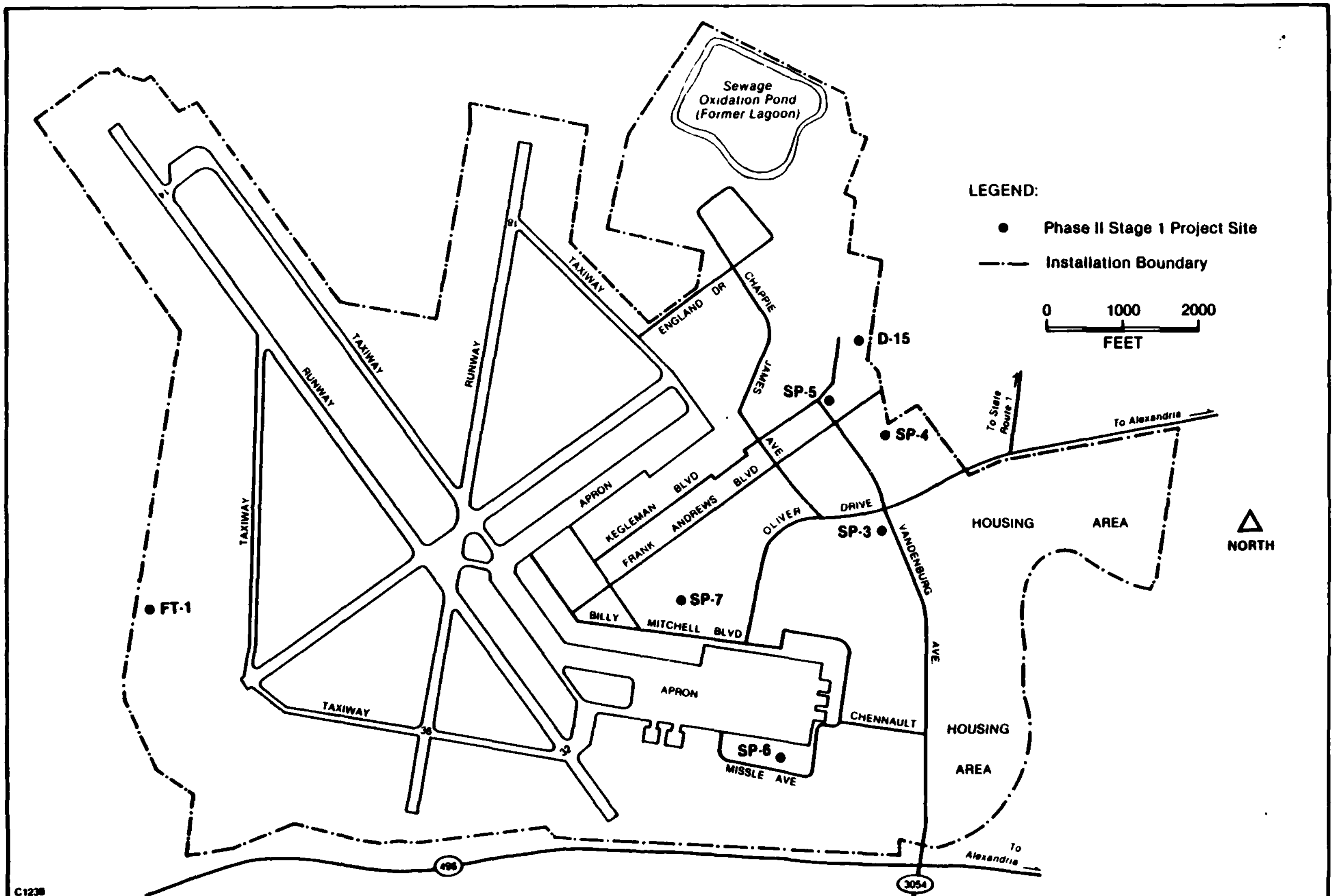

Figure 1. Installation Restoration Program (IRP) Phase II Stage 1 Project Sites, England AFB, Louisiana.

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TABLE 2. POTENTIAL CONTAMINATION BY SITE, IRP PHASE II STAGE 1 ENGLAND AFB

Site	Potential Contamination Source	Potential Contaminants
FT-1	Fire Training Area	Waste oils and sludges, JP-4
D-15	POL Sludge Weathering Pit	Sludge from POL tanks, excavated soils saturated with JP-4
SP-3	Underground Line Leak	JP-4
SP-4	Underground Line Leak	JP-4
SP-5	Underground Line Leak	JP-4
SP-6	CE Tank Spill	Waste oils
SP-7	Motor Pool Tank Leak	MOGAS

type(s) of potential contamination suspected at each. Detailed site descriptions are provided in Section 2.4.

Field Program

The field program at England AFB consisted primarily of hand-augering soil borings and collecting soil and ground-water samples. A total of 96 soil samples were collected from 33 boreholes located within the seven Phase II Stage 1 project sites. One ground-water sample was collected from each project site plus one from each of three USGS monitor wells located along the base perimeter for a total of ten ground-water samples. All sampling locations are shown on Figure 2.

Ground-water and soil samples were analyzed for oil and grease using the infrared (IR) method (EPA Method 413.2). In addition, ground-water samples were analyzed for volatile aromatic hydrocarbons (EPA Method 602) using gas chromatography (GC).

Results of Analysis

Based on the results of the Phase II Stage 1 field evaluation at England AFB, variable but generally high values of oil and grease in soils from five of the seven Phase II Stage 1 sites (FT-1, D-15, SP-3, SP-6, and SP-7) strongly suggest that contamination has occurred at levels warranting further attention. Samples from all boreholes at these sites contain oil and grease in quantities beyond those which might be expected from natural sources.

Data from the other two Phase II Stage 1 sites (SP-4 and SP-5) cannot be definitively interpreted without baseline data with which to compare them. The concentrations of oil and grease obtained in analysis of these soils are significantly lower than at the other sites. However, due to the variability in the analysis it cannot be conclusively determined that these samples are uncontaminated.

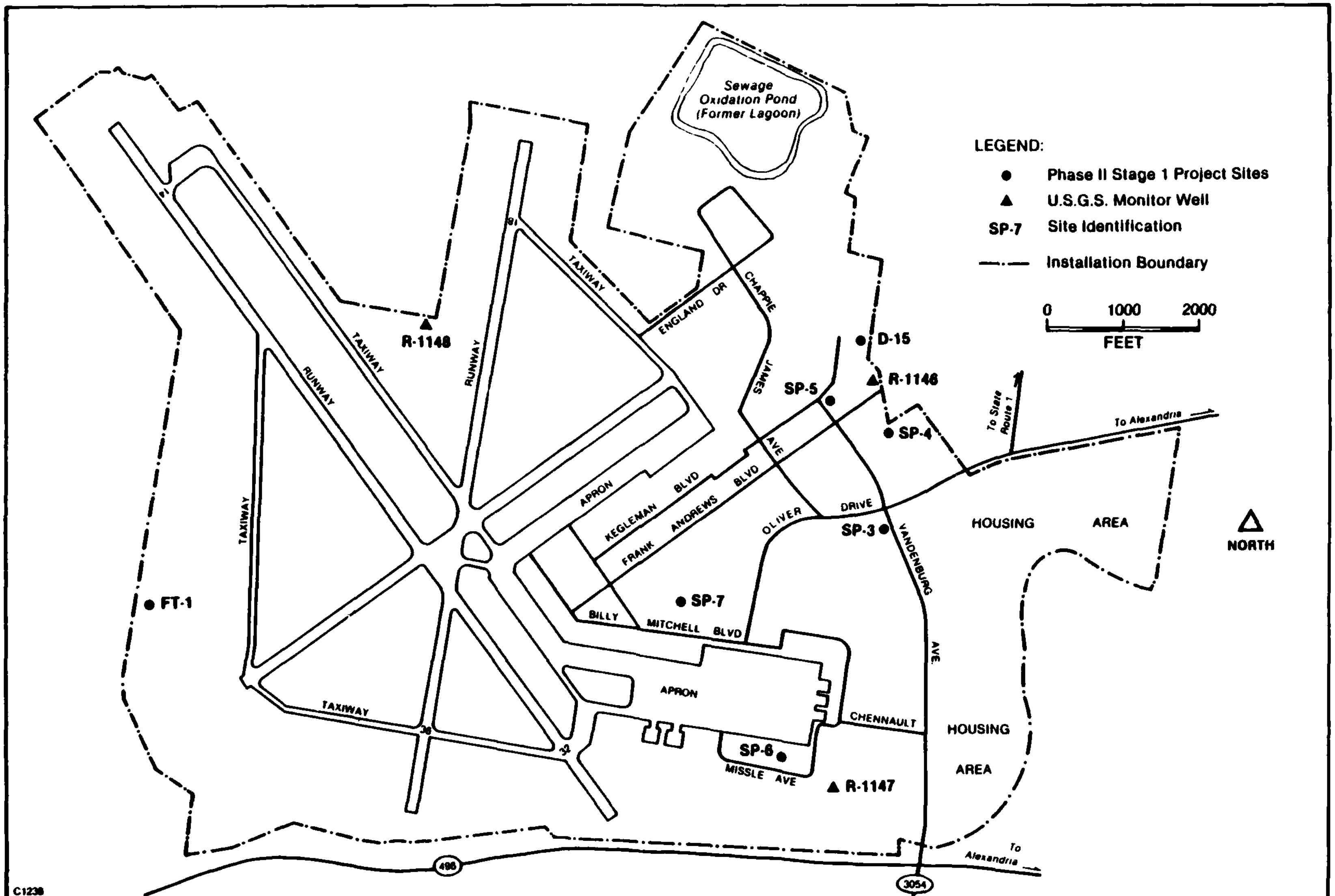

Figure 2. Locations of All Phase II Stage 1 Sampling Points, England AFB, Louisiana.

Oil and grease concentrations in ground water samples from all project sites except D-15 are of the same order of magnitude (<10 mg/L) as those from the three USGS monitor wells. The sample from site D-15 has a significantly higher oil and grease value of 20 mg/L. Migration of oil and grease into the shallow alluvial aquifer may be significant at site D-15, but is not demonstrated on the basis of existing oil and grease data at any of the other sites. At the other six sites, any contamination by heavier hydrocarbons, as indicated by oil and grease, appears to be retained within the soils of the unsaturated zone.

Analyses for volatile aromatic hydrocarbon (EPA Method 602) compounds in a single ground-water sample from each project site confirms the contamination suggested by the oil and grease data from soils at sites FT-1, D-15, SP-3, SP-6, and SP-7. EPA 602 data indicate elevated concentrations of one or more volatile aromatic hydrocarbon compounds relative to background, in the ground-water samples from these sites.

Conclusions

Analyses conducted to date confirm environmental contamination at five of the seven Phase II Stage 1 project sites (FT-1, D-15, SP-3, SP-6, and SP-7). However, a determination of the extent of contamination and potential for off-site migration will require additional field and analytical efforts. On the basis of existing soils data, the significance of environmental contamination cannot be conclusively determined at sites SP-4 and SP-5. Thus, all Phase II Stage 1 project sites are classified as Category II: sites which require additional monitoring or work to assess the extent of current or future contamination.

Analyses for volatile aromatic hydrocarbon (EPA Method 602) compounds in a single ground water sample from sites FT-1, D-15, SP-3, SP-6, and SP-7 confirm the contamination indicated by the oil and grease data from soils. EPA 602 data indicate that significant quantities of one or more volatile aromatic hydrocarbon compounds have migrated into the shallow ground-

water system at these sites. In addition, the ground-water sample from site D-15 contains oil and grease at a significantly higher concentration than in samples from the other sites or from the three USGS monitor wells. At the other six sites, any contamination by heavier hydrocarbons, as indicated by oil and grease, appears to be retained within the soils of the unsaturated zone.

Recommendations

Based on the findings of this study, Radian recommends additional Phase II activities at each of the Phase II Stage 1 project sites. The recommended actions are designed to better characterize the significance of environmental impacts and the potential for off-site migration associated with each site. Radian's recommendations are prioritized in Table 3, based on the apparent severity of contamination determined by Phase II Stage 1 analyses. In addition, Radian recommends that sites which received intermediate HARM scores, but were not recommended for Phase II study in the Phase I report, be re-evaluated in consultation with England AFB personnel.

TABLE 3. RECOMMENDATIONS FOR ENGLAND AFB IRP PHASE II STAGE 2

Site	Recommended Action	Rationale
SP-7 (MOGAS Underground Tank Leak)	Install a minimum of three downgradient monitor wells to a depth of 10 ft below the local water table in the vicinity of SP-7. Monitor wells should be sampled quarterly and analyzed for EPA Method 602 compounds, and analyzed at least annually for oil and grease. Duration of monitoring and modifications in original sampling schedule are dependent on analytical results.	Ground-water samples from this site have the highest concentrations of volatile aromatic hydrocarbons identified in this stage of investigation. The levels of benzene and ethyl benzene in the site ground-water sample both exceed EPA's human health criteria for these compounds. Soil samples are also significantly contaminated with oil and grease; however, the levels in ground water are only slightly above background at this time.
D-15 (POL Sludge Weathering Pit)	Install a minimum of three downgradient monitor wells to a depth of 10 ft below the local water table in the vicinity of D-15. Wells should be sampled quarterly. Surface water samples should be obtained quarterly from the drainage ditch at a point adjacent to the site and a second point where the ditch discharges into Big Bayou. All samples should be analyzed for EPA Method 602 compounds and for oil and grease.	Ground water from this site has the highest oil and grease concentration found anywhere on base. At 20 mg/L, this level is almost five times the average background concentration. Benzene was also identified at relatively high levels, and site soils include variable, but generally significant concentrations of oil and grease. Finally, the observed connection between ground- and surface water at this site is the basis for recommended surface water sampling.
SP-3 (JP-4 Underground Line Leak)	The recommendations for additional activities are the same as those for site SP-7.	Significant levels of benzene, and concentrations of oil and grease which are somewhat higher than background levels were identified in the site ground-water sample. Site soil samples also show significant levels of oil and grease.
FT-1 (Fire Training Area No. 1)	Install five to six additional soil borings in the downgradient direction, beyond those emplaced in the first stage of field sampling. Collect soil samples at 2.5 ft intervals to the water table or to a maximum depth of 10 ft. Also collect grab water samples from at least two of the borings fitted with temporary PVC screens. Analyze all soil and ground-water samples for EPA Method 602 compounds.	The main purpose of the recommended actions is to determine the extent of contamination at this site. Even though benzene was detected at significant levels in the ground-water sample, the site is remote and the potential risk to receptors is low. Therefore, limited additional activities are proposed, utilizing a phased approach to better define the potential impact of this site.

(Continued)

TABLE 3. (Continued)

Site	Recommended Action	Rationale
SP-6 (CE Tank Spill)	Install one downgradient monitor well and sample ground water semi-annually for EPA Method 602 compounds and annually for oil and grease.	Soil samples are contaminated with oil and grease, however, ground-water concentrations are only slightly above background levels. The only volatile aromatic hydrocarbon species detected in the ground water is toluene and it is present at levels three orders of magnitude below EPA's human health criterion. Therefore, most contaminants appear to be retained in the soils and only a minimal ground-water monitoring program is recommended at this time.
SP-4 and SP-5 (JP-4 Underground Line Leaks)	Collect background soil samples at 2.5 ft intervals to a maximum depth of 10 ft from one borehole located near one of the USGS monitor wells. Analyze soil samples for oil and grease by IR (EPA Method 413.2). Compare these results to existing soils data from sites SP-4 and SP-5 to interpret the environmental significance of oil and grease concentrations in soils at these two sites.	No volatile aromatic compounds were detected in ground-water samples from either site and oil and grease levels were near background concentrations. Oil and grease were detected in soils from both sites, but at levels significantly lower than at the other project sites. The limited actions recommended could confirm the likelihood that neither site poses a threat to human health or the environment.

1.0 INTRODUCTION

1.1 Purpose

The Department of Defense (DOD) has developed the Installation Restoration Program (IRP) to identify, report and correct potential environmental deficiencies from past waste management activities that could result in ground-water contamination and probable migration of contaminants beyond DOD installation boundaries. The current DOD IRP policy is contained in Defense Environmental Quality Program Policy Memorandum (DEQPM) 81-5, dated 11 December 1981 and implemented by Air Force message dated 21 January 1982. The IRP is a four-phase program consisting of: Phase I, Problem Identification/Records Search; Phase II, Problem Confirmation and Quantification; Phase III, Technology Development, and Phase IV, Corrective Action. The Phase I study for England AFB, Alexandria, Louisiana has been completed and reported (Engineering-Science, 1983). Presented in that report are descriptions of the installation and its environmental setting, a review of industrial operations and base support activities conducted at the base, an inventory of major solid and hazardous wastes from past activities, a review of past waste handling, treatment and disposal facilities, and an evaluation of the pollution potential of each identified site.

For Phase II Stage 1 Radian Corporation has investigated impacts to the soils and ground water at selected waste disposal sites on England AFB. The purpose of this investigation was to determine if contamination has occurred from waste disposal practices, or from fuel or other spills. This study was undertaken under USAF Contract F33615-83-D-4001, Delivery Order 10.

1.2 Duration

The Phase II Stage 1 Delivery Order was effective 27 January 1984. Field activities were conducted from 27 February through 5 March 1984. During this time, 33 soil borings were hand-augered at seven sites. A total of 96 soil samples were collected and analyzed for oil and grease by the infrared

(IR) method (EPA Method 413.2). In addition, one ground-water sample was collected from each of the seven project sites and from each of three USGS monitor wells that tap the shallow alluvial aquifer. Each of these 10 ground-water samples was analyzed for oil and grease (EPA Method 413.2) and for volatile aromatic hydrocarbons (EPA Method 602).

1.3 History

The site now occupied by England AFB was opened in 1942 as Alexandria Army Air Base. Until 1945, the facility was used as a bomber combat crew training school. Early in 1946, the base was placed on standby status and was eventully turned over to the City of Alexandria for use as a municipal airport. The base was reactivated as Alexandria Air Force Base in 1950. That same year, it was assigned to Tactical Air Command. In June 1955, the base was officially renamed England Air Force Base.

Since July 1972, the 23rd Tactical Fighter Wing (TFW) Tactical Air Command, has been the host unit on base. The 23rd TFW is currently equipped with the Fairchild Republic A-10 Thunderbolt II aircraft.

The 23rd Tactical Fighter Wing's mission is to maintain a combat ready posture capable of worldwide deployment to bases and forward operating locations with minimum support facilities. It conducts close air support, joint anti-armor operations, battlefield interdiction, search and rescue missions, and employment of conventional munitions (including AGM-65 Maverick missiles) against surface targets. A total of fourteen major tenant organizations are located at England AFB.

In Phase I, 20 different sites were identified which may have contributed to environmental contamination. The activities creating these potential impacts date back to the 1940's and include general refuse disposal, landfilling of low-level radioactive and hazardous wastes, sludge weathering and spreading, spills and leaks, and storage and fire training areas. A listing of these sites is presented in priority-ranked order in Table 1-1.

TABLE 1-1. PRIORITY RANKING OF POTENTIAL CONTAMINATION SOURCES, FROM IRP PHASE I, ENGLAND AFB (Engineering Science, 1983)

Rank	Site No.	Site Name	Date of Operation or Occurrence
1	FT-1	Fire Training Site No. 1	1940's-1964
2	D-15	POL Sludge Weathering Pit	1950's-1982
3	SP-4	JP-4 Underground Line Leak	1977-1978
4	SP-5	JP-4 Underground Line Leak	1981
5	FT-3	Fire Training Area No. 3	1966-1980
6	SP-3	JP-4 Underground Line Leak	1977-1978
7	SP-2	Tank 1319 JP-4 Spill	1969
8	S-1	Waste Oil Storage Tank	1965-mid 1970's
9	D-3	General Refuse Disposal Site	1950's
10	D-8	Chlorine Gas Cylinder Disposal Site	Early 1960's
11	D-10	Hazardous Chemical Burial Mound	1945-1946
12	S-6	Lake Charles Drum Storage Site	?-Present
13	FT-2	Fire Training Site No. 2	1964-1966
14	FT-4	Fire Training Site No. 4	1980-1982
15	D-4	General Refuse Disposal Site	Late 1950's-Early 1960's
16	D-5	General Refuse Disposal Site	Early 1960's-mid 1960's
17	SP-6	CE Tank Spill	1970's-1980's
18	SP-7	Motor Pool Underground Tank Leak	1976-1977
19	RD-1	Low-Level Radioactive Waste Disposal Site	1957-1958
20	RD-2	Low-Level Radioactive Waste Disposal Site	Unknown

1.4 Description of Sampling Sites

The 20 sites of potential contamination identified in Phase I included spills and leaks, fire training areas, land disposal areas, and areas used for a variety of other waste management practices. The Phase II Stage 1 study evaluated a total of seven sites; six recommended for study in the Phase I report and the site of a suspected MOGAS leak (SP-7) recommended for inclusion by England AFB personnel. Further conversations with England AFB personnel suggest that some of the remaining 20 sites identified in Phase I may require additional study in subsequent Phase II stages of investigation. Figure 1-1 shows the locations of the seven Phase II Stage 1 project sites.[1] Table 1-2 outlines the type(s) of potential contamination suspected at each.

1.5 Pollutants Analyzed

All soil and ground-water samples collected in Phase II Stage 1 were analyzed for oil and grease by IR (EPA Method 413.2). A total of 10 ground-water samples (one from each project site plus one from each of three USGS monitor wells) were analyzed for oil and grease (IR) and for volatile aromatic hydrocarbon (EPA Method 602) compounds. The EPA 602 compounds are listed in Table 1-3. In addition, field measurements of temperature, pH, and conductivity were taken for each ground-water sample.

1.6 Field Team

Radian Corporation assembled a team of experienced professionals to conduct soil and ground-water sampling activities at England AFB, and to provide coordination with Air Force personnel. Project personnel and their responsibilities are summarized in Table 1-4. Complete resumes are provided in Appendix A.

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[1] The SP-5 location identified in the IRP Phase I report is not correct. The actual location of SP-5 was identified by England AFB personnel during the Phase IIA site visit. OEHL (per Maj. Swoboda) concurred with the corrected location and instructed that the field activities take place at the newly designated location. The correct location is shown on Figure 1-1 and all subsequent maps.

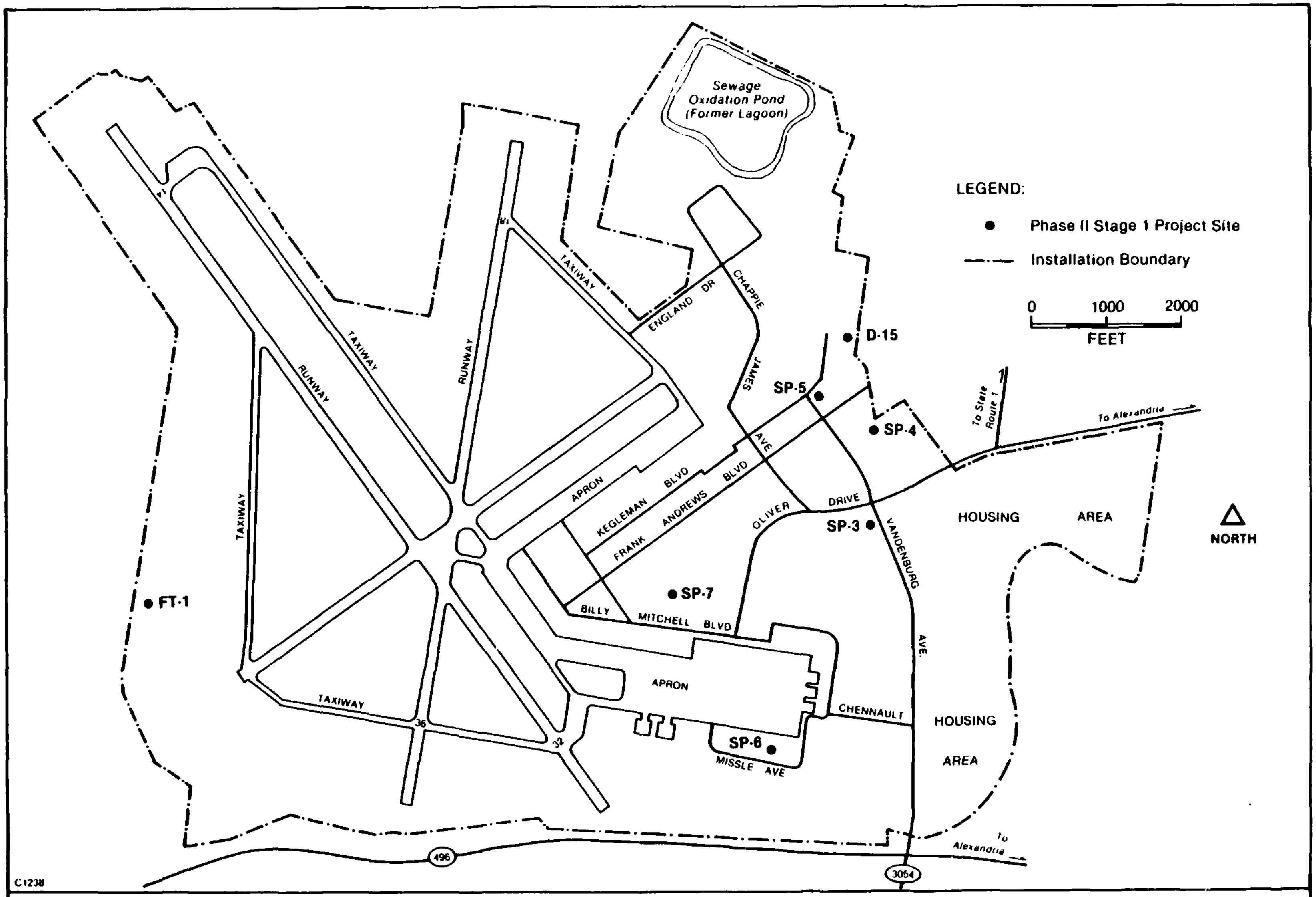

Figure 1-1. Installation Restoration Program (IRP) Phase II Stage 1 Project Sites, England AFB, Louisiana.

TABLE 1-2. POTENTIAL CONTAMINATION BY SITE, IRP PHASE II STAGE 1 ENGLAND AFB

Site	Potential Contamination Source	Potential Contaminants
FT-1	Fire Training Area	Waste oils and sludges, JP-4
D-15	POL Sludge Weathering Pit	Sludge from POL tanks, excavated soils saturated with JP-4
SP-3	Underground Line Leak	JP-4
SP-4	Underground Line Leak	JP-4
SP-5	Underground Line Leak	JP-4
SP-6	CE Tank Spill	Waste oils
SP-7	Motor Pool Tank Leak	MOGAS

TABLE 1-3. VOLATILE AROMATIC HYDROCARBONS BY GAS CHROMATOGRAPHY (GC) (EPA METHOD 602)

Benzene	1,2-Dichlorobenzene
Toluene	1,3-Dichlorobenzene
Ethyl Benzene	1,4-Dichlorobenzene

TABLE 1-4. PROJECT PERSONNEL FOR ENGLAND AFB IRP PHASE II STAGE 1

Name	Degree	Years Experience	Responsibilities
Marshall F. Conover	B.A.	26	Contract Administrator
Thomas W. Grimshaw	Ph.D.	13	Program Manager
Debra L. Richmann	M.A.	9	Project Director, Field Sampling
Fred B. Blood	M.S.	11	Field Sampling

2.0 ENVIRONMENTAL SETTING

The discussion of the England AFB environmental setting was principally derived from the Installation Restoration Program Phase I Records Search report (Engineering-Science, 1983). The following sections describe the environmental setting of England AFB in terms of the physical geography, geology, and hydrogeologic conditions of the area. Basic features and history of the specific sites investigated in this study are also discussed here.

2.1 General Setting and Physical Geography

England AFB is located in central Louisiana approximately five miles west of the town of Alexandria in eastern Rapides Parish. The main installation consists of 2,613 acres with a base population of more than 8,000 people. England AFB is roughly bordered by State Route 1 to the north and State Highway 496 to the south. The general location and features of England AFB are illustrated in Figures 2-1 and 2-2.

England AFB is located in the Red River Valley subdivision of the West Gulf Coastal Plain. The valley land is characterized by level to gently sloping terrain. Area streams have developed broad, nearly level flood plains. The most prominent features of the region are dissected terraces flanking the valley (Newcome, 1960).

Elevations in the Red River valley range from 40 to 205 feet MSL, while outside the valley surface elevations reach a maximum of 310 feet MSL. At England AFB, surface elevations vary from 75 feet MSL in the drainage channel adjacent to the golf course, to 90 feet MSL along the west installation boundary (installation documents). Local relief is seldom more than five feet and normally occurs as a gentle slope. The greatest variations in relief within the installation occur along major water courses, such as Bayou Rapides.

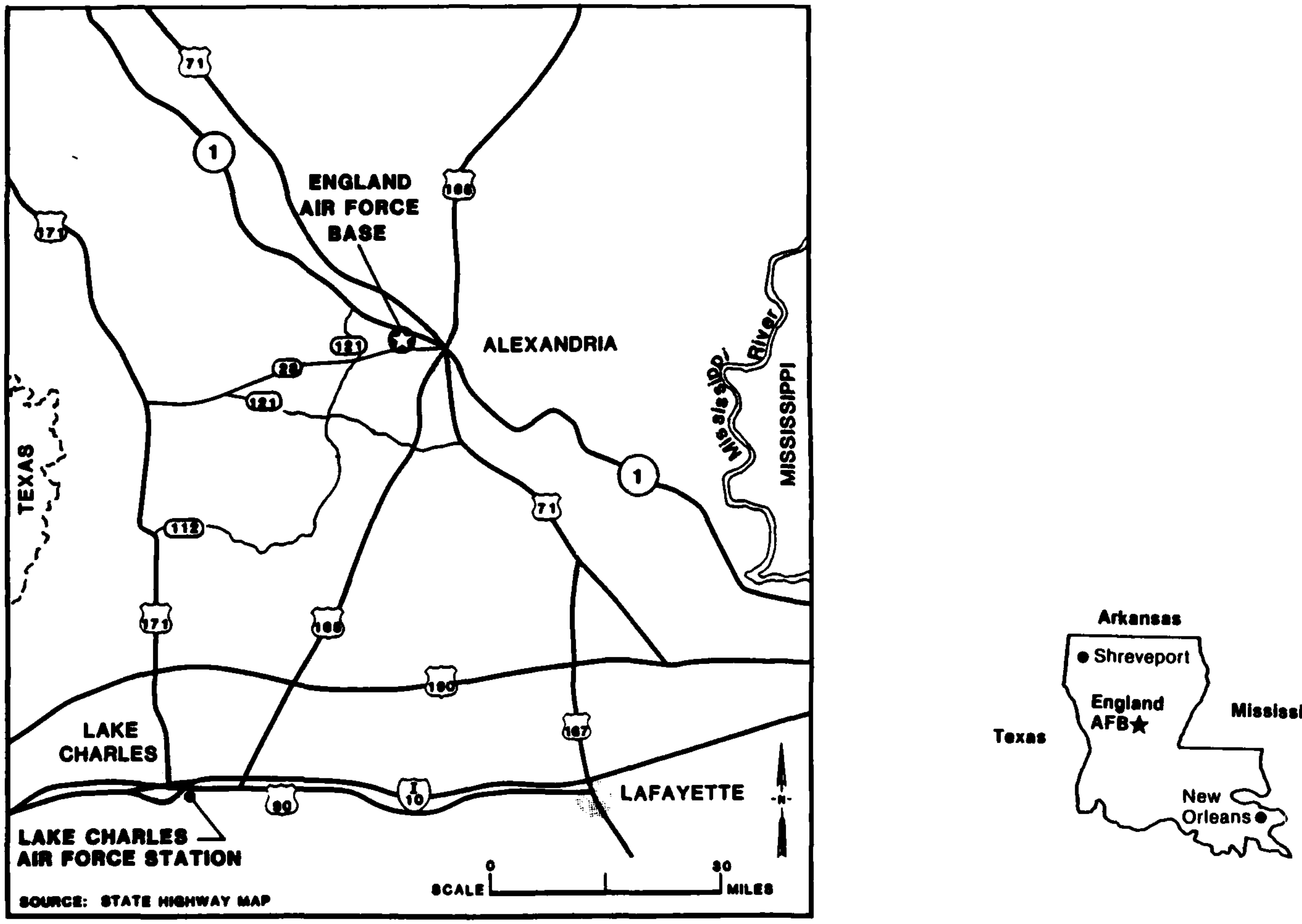

Figure 2-1. Regional Location of England AFB, Louisiana.

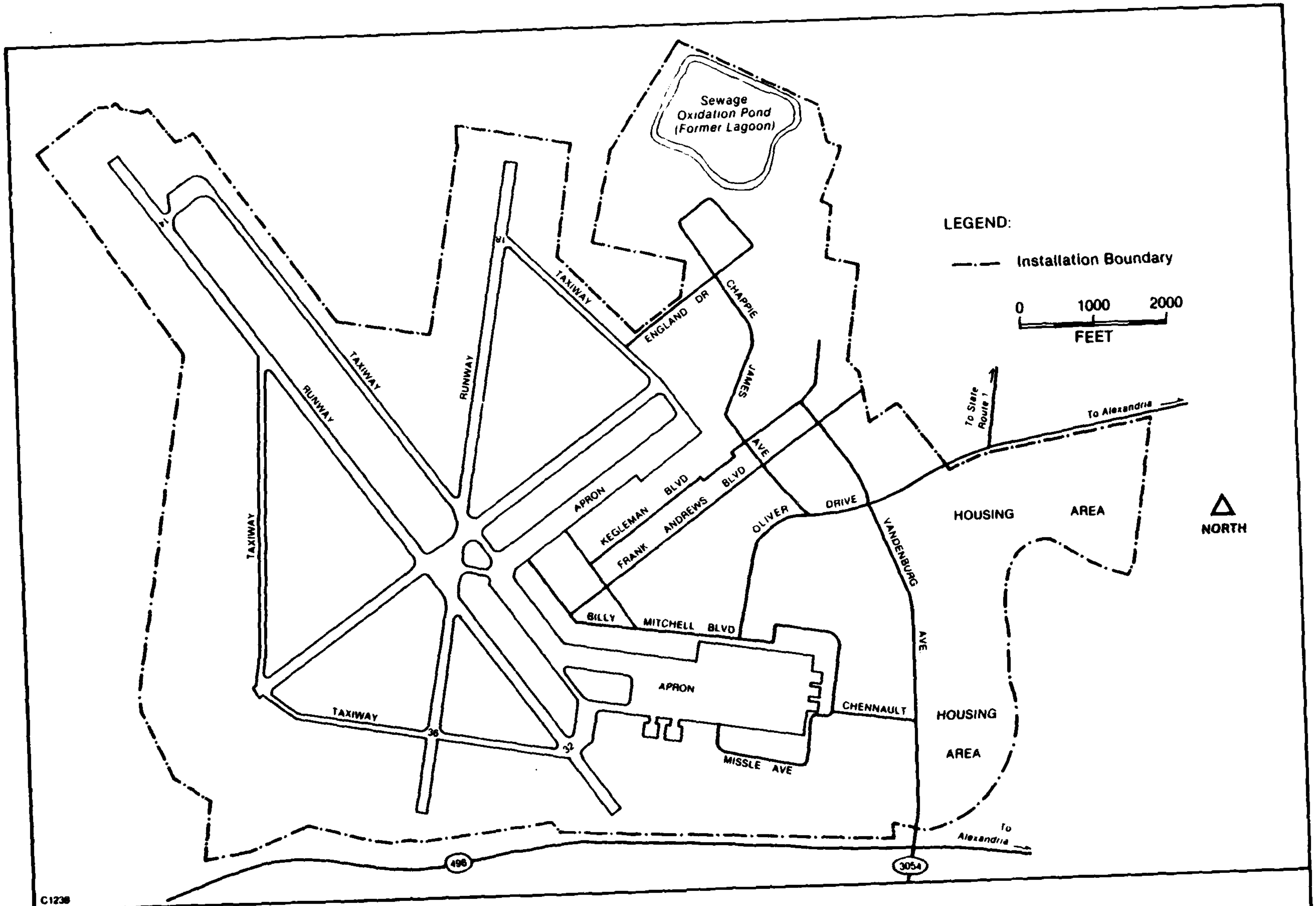

Figure 2-2. Major Features of England AFB, Louisiana.

The principal drainages for England AFB are Big Bayou on the north side of the installation and Bayou Rapides to the south. Drainage to the creeks is accomplished from diversion structures which collect overland flow from the installation. In general, area streams flow in an eastward direction, discharging to the Red River. The area immediately adjacent to the streams is characterized by natural levees, backwater swamps and seasonally flooded zones.

During periods of peak flow, Bayou Rapides is isolated from the Red River by flood gates to prevent flooding of interior lowlands. According to data from the U.S. Corps of Engineers, England AFB is not located within a 100-year flood zone and no wetlands have been identified on base.

2.2 Geology

Information describing the geologic setting of England Air Force Base was obtained from Whittemore (1941), Fisk (1940), Woodward and Gueno (1941) and Frink (1941). Additional information was obtained from interviews with U.S. Geological Survey (USGS) personnel during the Phase I study.

Regional Geology

The geologic units in the project region range in age from Paleocene to Recent. They were deposited on a Cretaceous surface that dips gently southward. These units consist of unconsolidated materials including clay, silt, sand, gravel, marl, and consolidated units of shale and sandstone (Newcome, 1960). Table 2-1 (from Rollo, 1960) summarizes the post-Cretaceous geologic formations and describes their significant characteristics.

Surface Soils

Surface soils of the England Air Force Base project area have been mapped by the USDA Soil Conservation Service (1980). Three soil units have been identified within installation boundaries; Moreland Clay, Norwood silt

TABLE 2-1. GENERALIZED POST-CRETACEOUS STRATIGRAPHIC COLUMN FOR LOUISIANA

System	Series	Group	Formation	Lithology and Water-Bearing Characteristics
Quaternary	Pleistocene & Recent		Alluvium & Terrace	Clay, sand, and gravel. Permeable deposits yield large quantities of water, which generally is hard. Yields of wells are as much as 6,000 gpm.
Tertiary	Pliocene			Clay and sand. Sands yield moderate to large quantities of soft water, as much as 3,200 gpm.
	Miocene			Clay and sand. Sands yield moderate to large quantities of soft water. Wells tapping thick saturated sections may yield 1,500 gpm or more.
	Oligocene Eocene	Vicksburg Jackson		Carbonaceous shale and clay, and marl. Silt and very fine sand in the outcrop areas yield small quantities of water locally. Generally not considered water bearing.
		Claiborne	Cockfield	Clay and sand. Sands yield moderate quantities of water, which range from soft to very hard.
			Cook Mtn.	Clay and marl. Generally not water bearing.
			Sparta Sand	Sand and clay. Sands yield large quantities of soft water, as much as 2,000 gpm.
			Cane River	Clay and marl. Generally not water bearing. Interpretation of electrical logs of oil-test wells indicate that a sandy facies in northern Caddo and Bossier Parishes contains fresh water.
	Paleocene	Wilcox		Clay and sand. Sands yield small to moderate quantities of fresh water of variable quality. Water may be saline locally. Yields of wells may be as much as 500 gpm.
		Midway		Clay and shale. Not considered water bearing.

Source: Rollo (1960).

loam and Norwood silty clay loam. The individual units are described in Table 2-2 and are mapped as Figure 2-3. These soils are typically fine-grained, have relatively low permeabilities and exhibit poor internal drainage characteristics. The soil units also are characterized by shallow water tables. All Phase II Stage 1 project sites are located on the Norwood silt loam unit (Nd).

Stratigraphy and Distribution

The surface distribution of major geologic units in the project area is presented in Figure 2-4, which is modified from the work of Rollo (1960). Generally, the geology of England AFB is dominated by a moderately thick section of alluvium overlying Miocene strata.

The alluvium, occupying the Red River valley (and flood plain), consists of clay, silt and sand with some local accumulations of gravel. The unit reaches maximum thickness of approximately 120 feet at USGS well R-1148 located on England AFB and is generally poorly sorted. Coarser materials are present at depth within the unit and the materials tend to become finer upwards. Data from soil borings emplaced in support of geotechnical (foundation design) investigations indicate that shallow (less than fifteen feet below ground surface) alluvial soils are predominantly silts, clays and sandy silts. Ground water was encountered by the borings at depths below ground surface ranging from six to eleven feet. The shallow borings emplaced during the Phase II Stage 1 investigation support these findings. Complete descriptions of Phase II Stage 1 soil samples are reported in Appendix B.

Immediately underlying the alluvium are deposits of Miocene Age, which consist primarily of unconsolidated sediments (i.e., clay, silt, sand, gravel) and some consolidated materials (usually shales). Units of Miocene age have a total thickness of approximately 500 feet in northwest Rapides Parish and thicken substantially to 5,300 feet in the southeast corner of the parish.

TABLE 2-2. ENGLAND AIR FORCE BASE SOILS

Map Symbol	Unit Description	USDA Texture (major fraction)	Thickness (inches)	Unified Classification (major fraction)	Permeability (inches/hour)
Mna	Moreland clay, 0-1% slopes	Clay, silty clay, silty clay loam	64	CH, CL	0.06-<0.2
Nd	Norwood silt loam	Silt loam, silty clay loam, fine sandy loam	76	ML, CL, CL-ML	0.6-2.0
Nw	Norwood silty clay loam	Silty clay loam, silt loam, fine sandy loam	76	CL, ML, CL-ML	0.6-2.0

Source: USDA, Soil Conservation Service (1980).

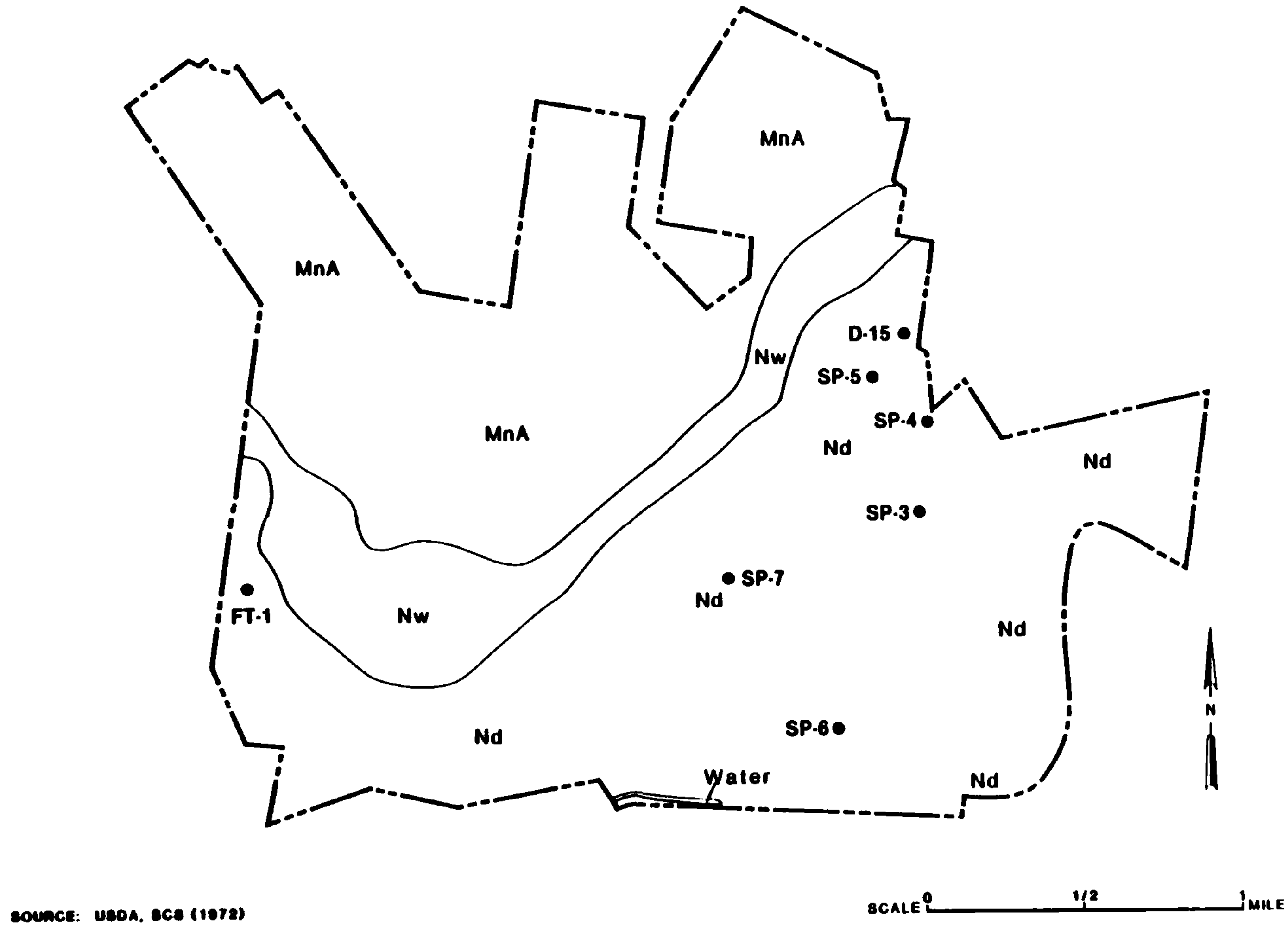

Figure 2-3. Distribution of Surface Soil Units and Project Sites (•), England AFB, Louisiana.

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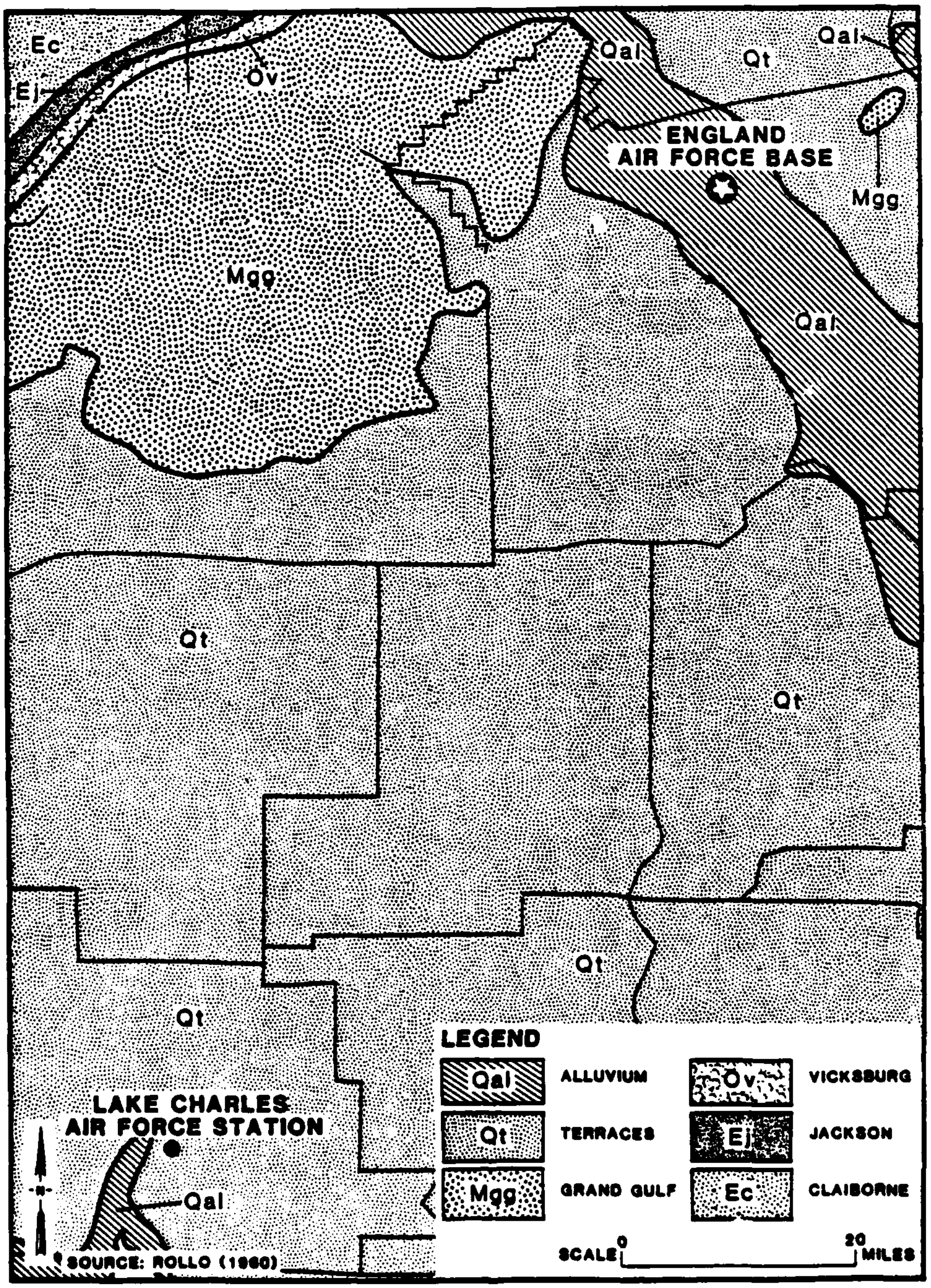


Figure 2-4. Surface Distribution of Major Geologic Units in the Vicinity of England AFB, Louisiana.

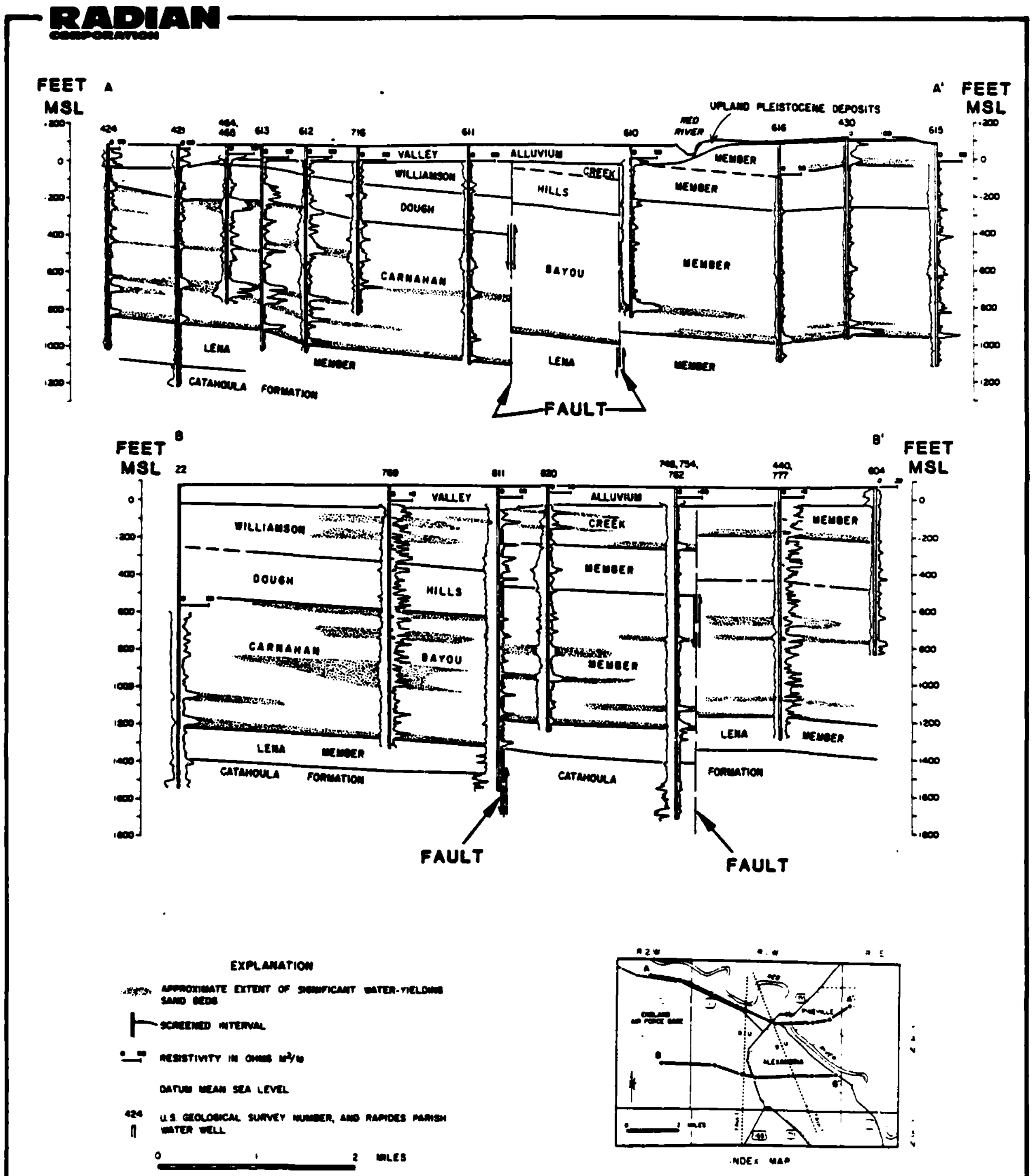
The Miocene section can be divided into two major formations, the Fleming Formation and the underlying Catahoula Formation (from Newcome and Sloss, 1966). The Fleming Formation is further subdivided into the Lena, Carnahan Bayou, Dough Hills, Williamson Creek, Castor Creek and Blounts Creek members. These units and their major subdivisions are shown in cross-section on Figure 2-5. In Rapides Parish, outcrops of Miocene materials are limited to the valley walls of deeply cut streams and to a 100-square mile area in the northwest corner.

The Miocene beds contain thick, predominantly sandy strata alternating with thinner clayey intervals (Newcome and Sloss, 1966). The thickest clay section present is the 300 foot thick Lena member, which forms the boundary between the Fleming and Catahoula Formations. Generally, sandy members of the Fleming Formation contain individual sand beds (better sorted sand deposits having few fines present), which have been classified and numbered to permit detailed study. These sand beds exist as lens-shaped deposits, frequently pinching out, which make correlation difficult over long distances.

Structure

The major structural features of Rapides Parish include the dip of the Miocene units and their local disruption by faulting. The Miocene units represented in the study area tend to thicken substantially downdip, to the south and southeast. Measurements taken on the basal beds of the series indicate a southward dip of 75 to 150 feet per mile (Newcome and Sloss, 1966). This follows the general regional trend of thickening toward the Gulf of Mexico.

Two north-trending faults disrupting Miocene units have been mapped in the England AFB area and other faults may be present. These faults are shown on Figure 2-5. According to Newcome and Sloss (1966), the potential impact of these faults may be great, as the offset caused by their movement may have joined, interrupted or altered previously discrete units. The modification of any water bearing units could subsequently influence the movement of ground water toward discharge points.



SOURCE: MODIFIED FROM NEWCOME and SLOSS (1966)

Figure 2-5. Regional Geologic Cross-Sections in the Vicinity of England AFB, Louisiana.

2.3 Hydrogeologic Conditions

Information on the ground-water hydrology of the project area has been reported by Klug (1955), Newcome (1960), Rollo (1960), Newcome and Sloss (1966) and Terry et al. (1979). Additional information was obtained from interviews with U.S. Geological Survey personnel and the Alexandria Municipal Water Department during the Phase I study.

In the England AFB area, two major sources of ground-water supplies have been identified. These include the Red River Alluvium (shallow unit) and the Miocene Deposits (deep unit).

Shallow Unit

The Red River Alluvium forms a significant aquifer in the Alexandria area and occurs at or near ground surface at England AFB. The unit is variably permeable and corresponds to that described in the discussion of site geology. Ground water occurs at shallow depths in the alluvium under both water table (unconfined) and artesian conditions (confined).

Recharge of the alluvium occurs primarily by precipitation falling on exposed portions of the unit. According to Newcome and Sloss (1966), this unit also receives recharge from adjacent upland Pleistocene terrace sands and from underlying Miocene deposits. Recharge received from the Pleistocene terrace moves under the influence of gravity to the alluvium where hydraulic pressures decrease. In some areas, additional recharge under artesian pressure, is transmitted upward to the alluvium from the Miocene. Prior to the development of Miocene aquifers for water resources, all valley alluvium received some degree of recharge from the Miocene (Newcome and Sloss, 1966).

At England AFB, ground-water levels in the alluvium have been monitored in three observation wells installed by the U.S. Geological Survey (USGS). Locations of observation and water supply wells are presented in Figure 2-6. A log of USGS Well No. 1148 is presented in Figure 2-7. A summary of water levels observed in the USGS alluvial wells at England AFB is presented in Table 2-3.

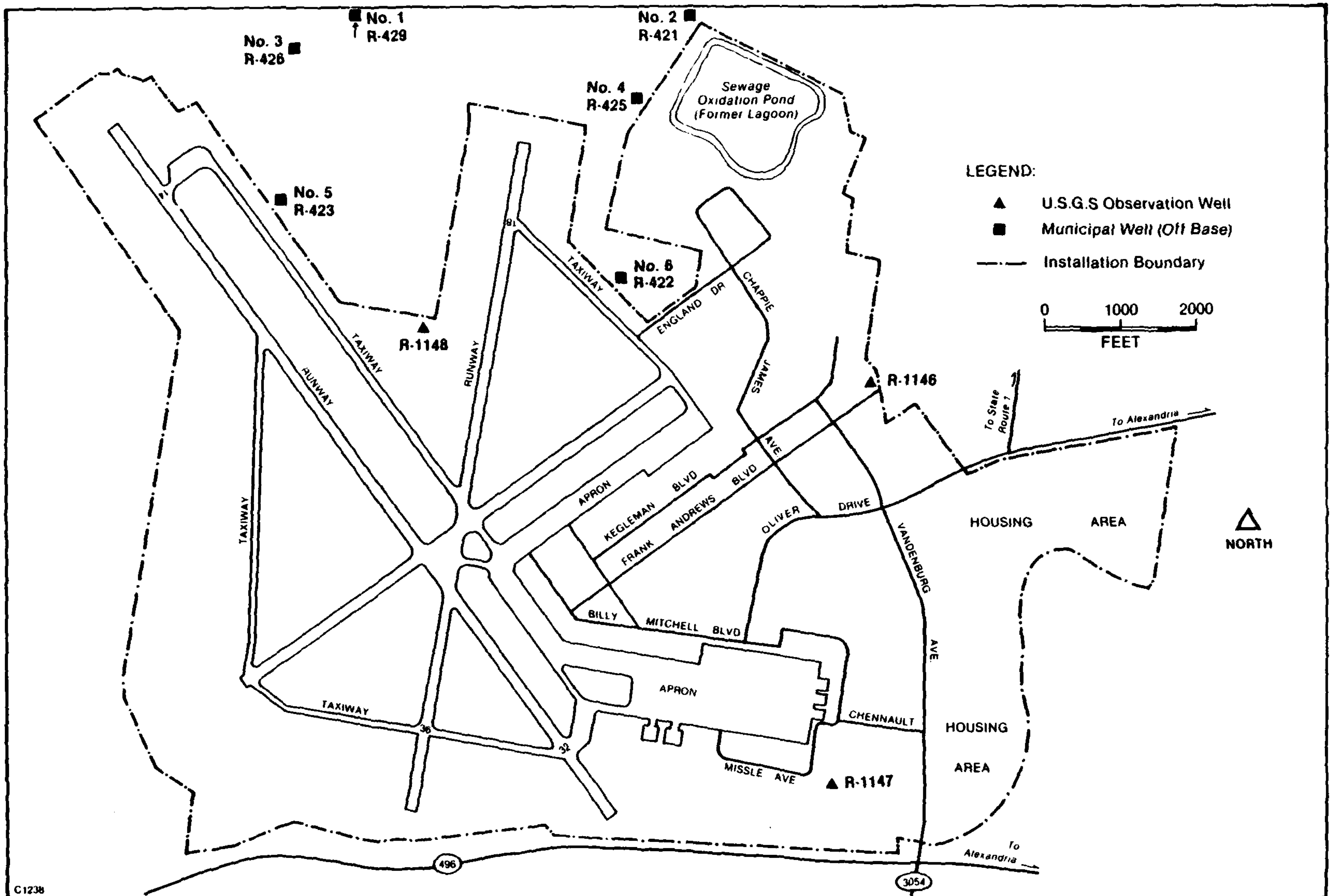


Figure 2-6. Locations of Observation and Water Supply Wells in the Vicinity of England AFB, Louisiana.

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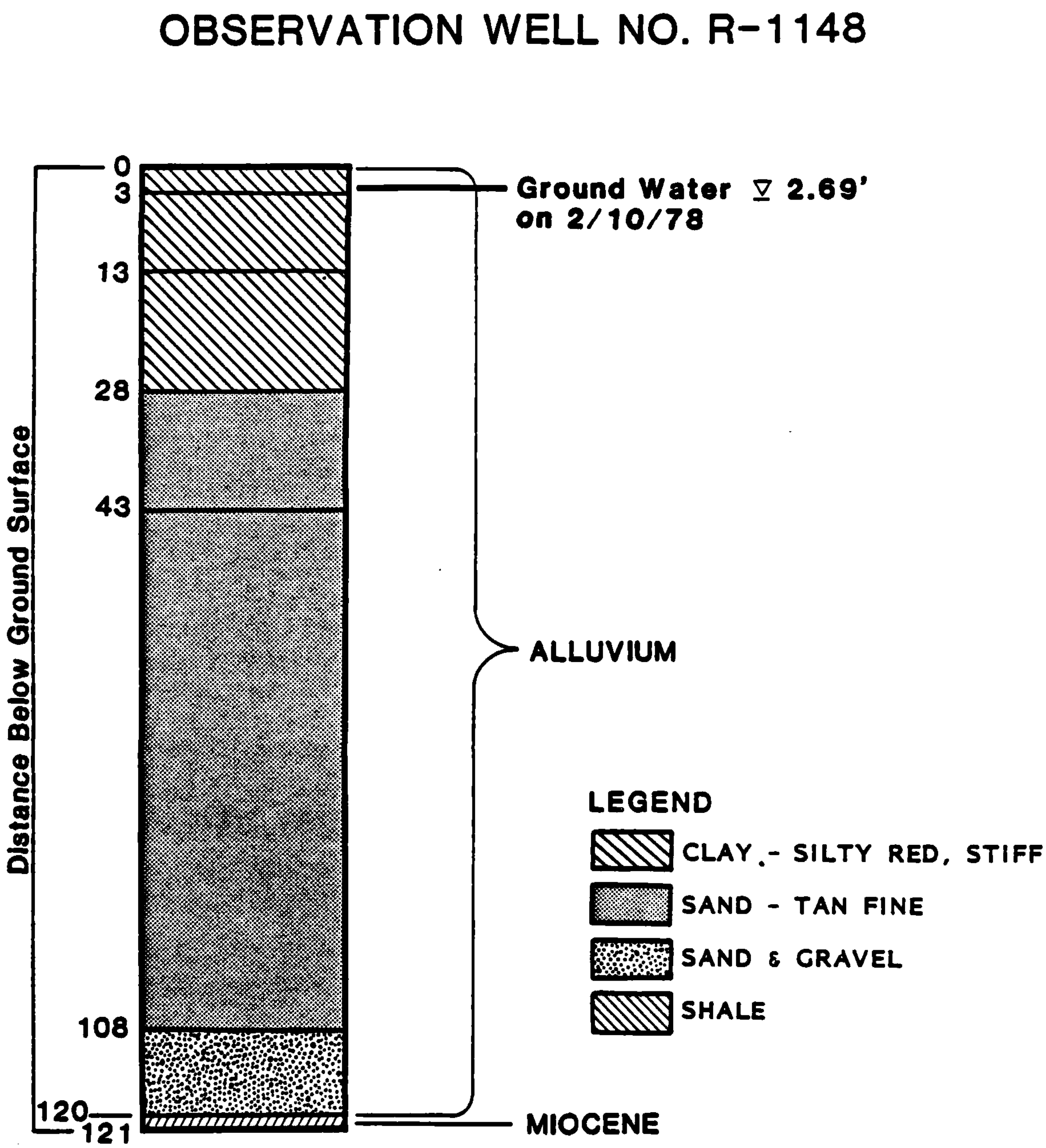

Figure 2-7. Lithologic Log of Alluvial Aquifer Observation Well No. R-1148, England AFB, Louisiana.

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TABLE 2-3. ALLUVIAL AQUIFER WATER LEVELS, ENGLAND AFB, LOUISIANA

USGS Well No.	Ground Water Depth Below Surface	Date of Measurement
R-1146	5.19 ft.	15 February 1978
R-1147	8.34 "	14 February 1978
R-1148	2.69 "	10 February 1978
R-1148	6.20 "	11 May 1978

According to D'Appolonia Consulting Engineers, Inc. (1980), alluvial ground-water levels at England AFB average ten feet below ground surface. A water level contour map for the area is presented in Figure 2-8.

Alluvial ground-water movement at England AFB is generally northeast to the Red River whose present bed (at an elevation of 15-35 feet, MSL) cuts into the aquifer along most of its course. During most of the year, ground water is discharged from the alluvial aquifer to the Red River and serves as the river's base flow. In October 1960, this discharge was measured at 20 mgd, an average of 0.4 mgd (0.6 cfs) per mile of valley in Rapides Parish (Newcome and Sloss, 1966). When the river is in flood stage, ground-water flow conditions reverse in areas adjacent to the river. This situation is normally of short duration. Thus, impacts are slight. A long term increase in river levels would lead to surface soil saturation and local fooding in valley lowlands, as the alluvial aquifer has little additional storage capacity available to retain large quantities of "new" water.

The close relationship between the alluvial aquifer and the Red River may be seen on the water level contour map, presented as Figure 2-8. This figure also illustrates general flow directions with respect to the project area.

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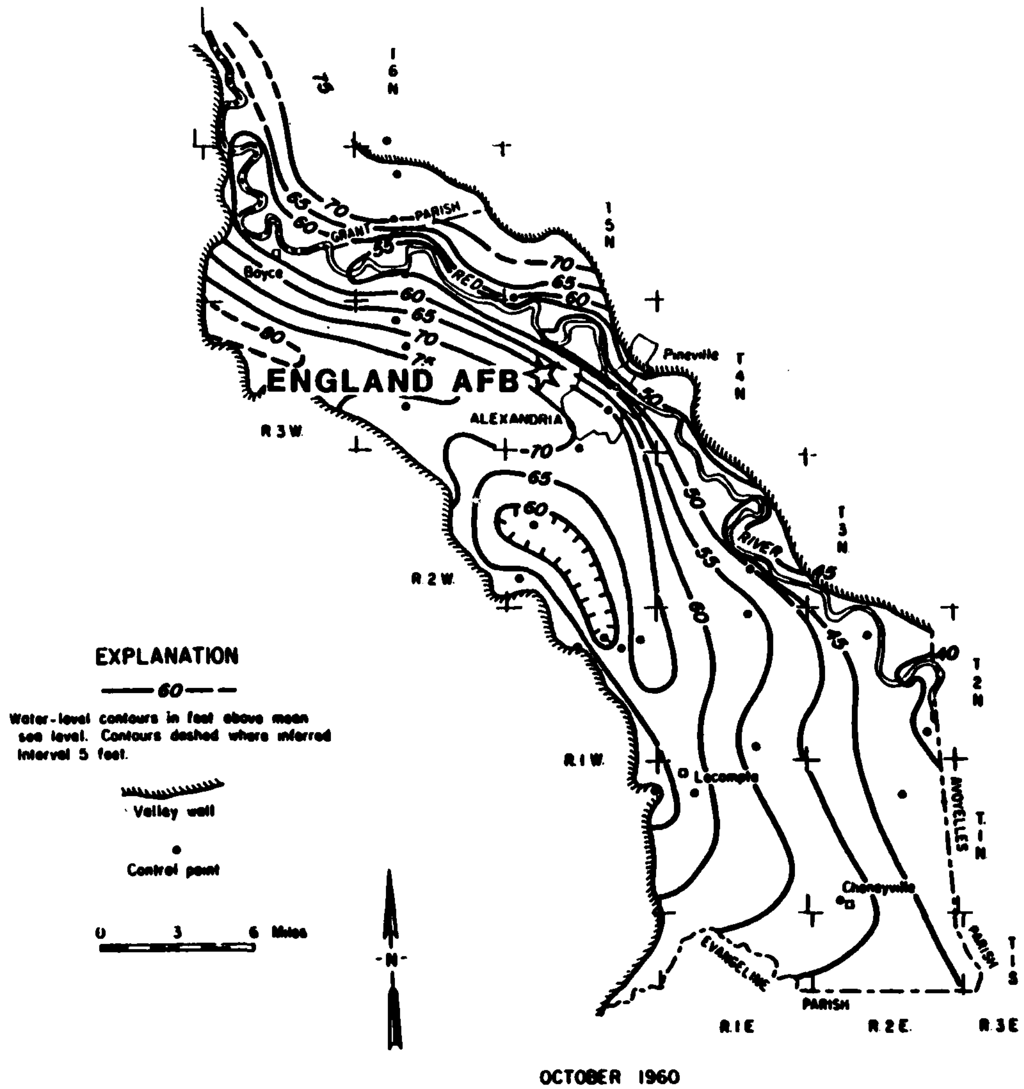

SOURCE: NEWCOME and SLOSS (1966)

Figure 2-8. Water-Level Contours Within the Shallow Alluvial Aquifer, England AFB and Vicinity, Louisiana.

Alluvial sands may provide large supplies of water for irrigation purposes. Wells 75 to 150 feet deep typically provide volumes in the range of 250 to 1700 gallons per minute. However, because of excessive hardness and iron content of the alluvial ground water, most domestic, municipal and industrial consumers use water from the Miocene aquifers underlying the alluvium.

Deep Units

The deep hydrogeologic units present in the study area are reported to be the major sand members of the Miocene-age Fleming and Catahoula Formations. The individual sand members are numbered and grouped into aquifers designated by the typical depths at which drillers encounter them in the Alexandria area. For example: the 400-foot, 700-foot, and 1000-foot sands are the most widely used aquifers in the project area. The sands are typically separated by interbedded clay or shale zones, which may be seen on Figure 2-9, the log of Alexandria Municipal Well No. 6 USGS No.R-422 (water level data were not available).

The Miocene aquifer is regional in extent and occurs within the Rapides Parish area at moderate depths ranging from approximately 100 feet below ground surface. It varies in thickness from approximately 500 feet to 5000 feet across the Parish. The aquifer receives recharge from rainfall on the outcrop in northwest Rapides Parish and in the parishes north and west of Rapides. Some recharge is available from overlying alluvium or from Pleistocene deposits in highland areas north and west of Alexandria, where hydraulic pressures are sufficiently high. Ground water usually occurs under artesian (confined) conditions within the Miocene sands. Average well depth in Rapides Parish is approximately 1100 feet. At England AFB, ground-water levels within this unit are approximately 190-200 feet below ground surface. Aquifer nomenclature and water levels are summarized on Table 2-4.

In past years, most discharge from the Miocene aquifers was directed upward, under the force of artesian presure, into the overlying alluvial deposits (Newcome and Sloss, 1966). Because concentrated pumpage at major

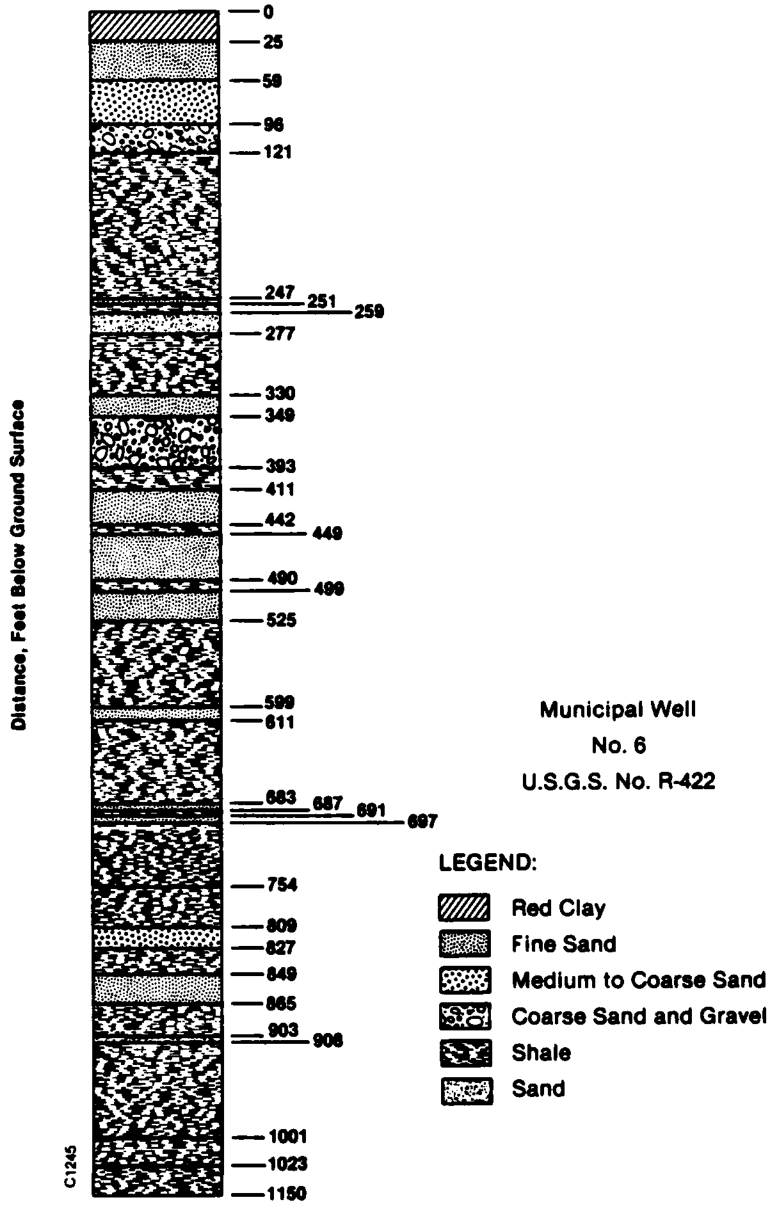

Figure 2-9. Lithologic Log of Alexandria Municipal Well No. 6 (USGS R-422).

SOURCE: Alexandria Municipal Water Department.

TABLE 2-4. MIOCENE AQUIFER DATA, ALEXANDRIA AREA, LOUISIANA

Sand*	Sand Designation by Klug (1955)	Elevation of Static Water Level, 1962 (feet, MSL)
WC-2	"400-ft." sand	-20 in city
WC-1	"400-ft." sand	-20 in city
CB-7	"400-ft." sand	At sea level near England AFB +15 near England AFB
CB-5	"700-ft." sand	At sea level to -125 in city -110 near England AFB
CB-3		-90 at National Guard Armory -175 at England AFB
CB-2	"700-ft." sand	-160 to -185 in city near England AFB
CB-1	"1,000-ft." sand	-25 to -100 in city
CB-0	"1,000-ft." sand	-50 to -160 in city -120 to -150 in England AFB area At sea level at National Guard Armory

* WC, Williamson Creek Member; CB, Carnahan Bayou Member.

Source: Newcome and Sloss (1966).

population centers such as Alexandria has reduced artesian pressures, discharge to alluvial materials now occurs locally, but not regionally. Along the valley margins west of England AFB, wetlands are maintained by flow from the Miocene aquifers.

Ground-water flow directions and velocities in the Miocene aquifers are strongly influenced by pumping. Figure 2-10 depicts Miocene aquifer water levels and generalized flow directions. Flow has been directed toward the large draw-down features caused by concentrated pumping, and natural discharge areas have been reduced in size. Ground-water flow in this aquifer sytem is apparently northeast with respect to England Air Force Base, toward the Bayou Rapides well field, just north of the base (well locations are shown on Figure 2-6).

According to Newcome and Sloss (1966), Miocene water levels have been reduced so drastically in some areas that a reversed hydraulic gradient has been created between the Miocene sediments and the overlying alluvium. In this case, the region's normal pattern has been reversed and the overlying alluvium is now recharging the Miocene sands.

Base Water Supplies

England AFB purchases its water resources from the Alexandria Municipal Well system. Wells are located throughout the Parish, are screened into the Miocene aquifers, and average 1100 feet in depth. Figure 2-9 is the log of a representative well in the Bayou Rapides field north of the base. Wells located immediately north of the installation furnish supplemental water to the Alexandria Municipal Well System.

2.4 Site Descriptions

Phase I studies for the England AFB Installation Restoration Program were completed by Engineering-Science in May 1983. The purpose of the Phase I study was to conduct a records search for the identification of past waste

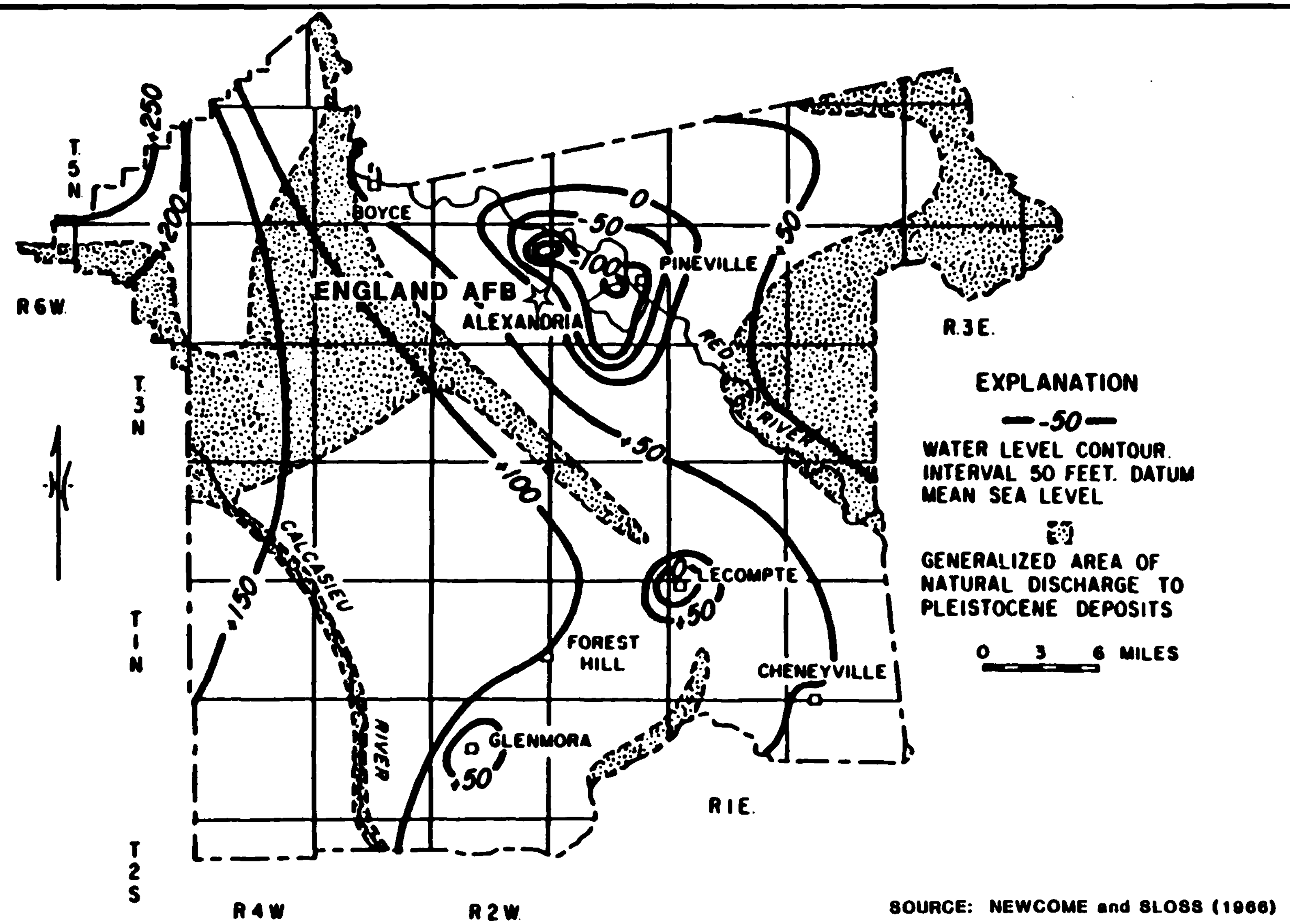

Figure 2-10. Water-Level Contours Within the Miocene Aquifer, England AFB and Vicinity, Louisiana.

management activities which could potentially cause ground-water contamination and the migration of contaminants off-base.

Twenty sites located on England AFB were identified as potentially containing hazardous waste. The potential environmental consequence of each site was evaluated using the HARM rating system. This system takes into account such factors as the site environmental setting, the nature of the wastes present, past waste management practices and the potential for contaminant migration.

Of the 20 individual sites identified, six sites were selected for Phase II studies based on the recommendation of the Phase I report. One additional site was added to the list for Phase II evaluation based on the findings of the Phase II presurvey report.

The general features of the sites evaluated in this study are discussed below as they are presented in the 1983 Engineering-Science report. Detailed features of each site are discussed in Sections 3.0 and 4.0. The locations of each of the sites are illustrated in Figure 2-11.

Site FT-1, Fire Training Site No. 1

Site FT-1, located near the west boundary of the base, was utilized from the early 1940's until 1964 as a fire training area. The site consisted of an approximate 100-foot diameter bermed area, a drum storage site, and an old B-29 aircraft. The drum storage site was utilized to store 20 to 30 55-gallon drums of contaminated oils and sludges resulting from refueling and aircraft maintenance. The drums were generally rusty and deteriorated and were stored on permeable soils. Approximately two times each month, the contaminated waste materials were mixed with JP-4, placed in a tank within the 100-foot bermed area, and ignited. Protein foams were then used to extinguish the fire. Due to the nature of the materials used at the site and since much of the present material may have seeped into the ground, a potential for contamination exists.

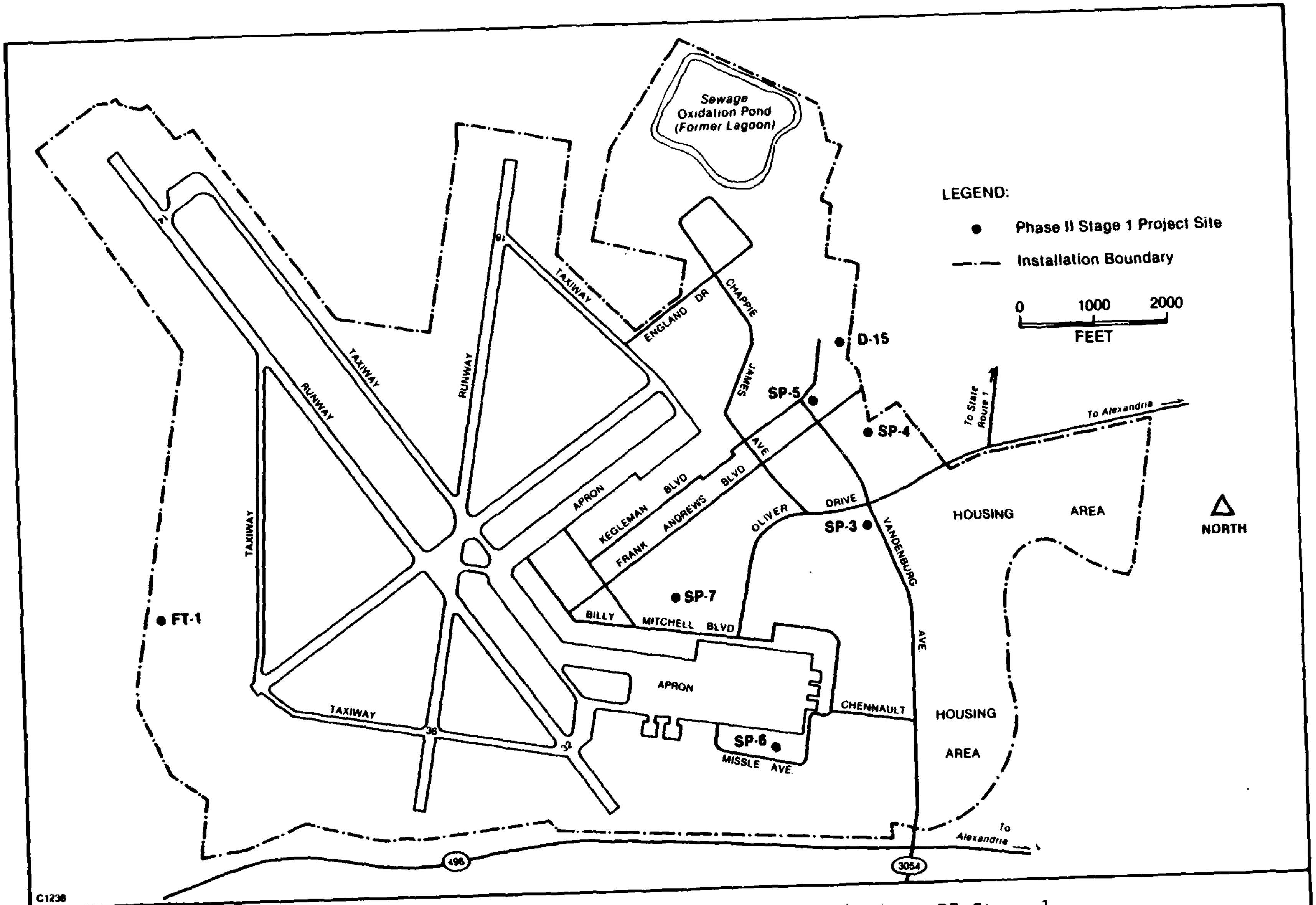

Figure 2-11. Installation Restoration Program (IRP) Phase II Stage 1 Project Sites, England AFB, Louisiana.

Site D-15, POL Sludge Weathering Pit

The POL storage area located near the east boundary of the base is a fenced, unpaved bulk storage area. From 1955 to 1982 an unlined pit approximately 2 to 4 feet deep and covering an area of about 900 square feet was used to weather spent fuel filters and sludge from tank clean-outs. The only non-fuels management use of the weathering pit was a one-time disposal of an unknown quantity of stripped acrylic floor finish that never totally evaporated. According to personnel interviews reported by Engineering-Science (1983) the ground-water would often rise above the bottom of the pit (Phase I report, p. 4-24) and the pit was partially filled with water at all times (Phase I report, p. 4-9). There is a small drainage ditch adjacent to the pit which discharges to Big Bayou. Due to the nature of the wastes, the shallow water table, and likely hydraulic connection between surface water and ground water, the potential for contamination does exist. The pit was covered with local soil in 1982 and regraded to surface contours (Phase I report, p. 4-9).

SP-3, JP-4 Underground Line Leak

In 1977 or 1978, a line leak occurred (Site SP-3) near the Golf Course Club House and an unknown quantity of JP-4 leaked and flowed into a nearby ditch. The fuel and saturated soil were collected and hauled to the area adjacent to Site D-15 (POL Sludge Weathering Pit) for dewatering and disposal. A new line was installed in 1981. As a result of this JP-4 spill, the potential for contamination exists at Site SP-3.

SP-4, JP-4 Underground Line Leak

During 1977-1978, a 1000 gallon JP-4 spill (Site SP-4) occurred as a result of a line break near building 1500 and the trailer park area. Part of the spilled JP-4 was recovered and contaminated soil was excavated from the site, hauled to Site D-15, and weathered. However, a potential for contamination still exists in this area.

SP-5, JP-4 Underground Line Leak

In 1981, a new JP-4 fuel line burst near Building 2325. Most contaminated soil was collected and hauled to Site D-15, the POL Sludge Weathering Pit. A low potential for contamination exists at this site due to the past cleanup and removal actions.

SP-6, Civil Engineering (CE) Tank Spill

This site includes a 6000 gallon underground CE storage tank located near building 2611 (the hydrant area) and is the location of several suspected spill incidents. The "slop tank" was first installed in 1972, and is used by many of the shops as an accumulation point for waste oils. The tank is pumped out every six months by a contractor who then disposes of the material off-site. Based on a site inspection at the tank and obvious discoloration of surrounding soil, spills have occurred in loading and/or unloading the tank. This spillage represents a potential for contamination.

SP-7, Motor Pool Tank Leak

In 1977, a 10,000 gallon motor pool tank (MOGAS) (SP-7) was replaced in the vicinity of Building 2005. The tank was suspected to be leaking and therefore, a potential for contamination exists at this site.

3.0 FIELD PROGRAM

The field program at England Air Force Base consisted of hand-augering soil borings and collecting soil and ground-water samples. The number of borings at each project site was specified in the Statement of Work (Appendix B). Minor adjustments to this guidance were made at the verbal request of the England AFB Bioenvironmental Engineer, but the total number of borings and samples authorized in the Statement of Work remained unchanged. Detailed descriptions of field activities at individual Phase II Stage 1 sites are provided in the following subsections. For each site, a similar sequence of events occurred:

- Soil boring locations were selected in accordance with guidance provided in the Statement of Work and Pre-Survey report, and were cleared with base personnel.

- Soil samples were collected at the surface with a trowel. Soil borings were accomplished using a manually advanced 3-1/4 inch diameter bucket-type auger. Samples were collected at 2.5 foot intervals to a maximum depth of 10 feet using a 21 inch extendable soil probe.

- Soil borings were extended to the depth of the local water table or to a maximum depth of 10 ft. A soil sample was taken at the water table, if encountered.

- One boring at each site was temporarily fitted with a slotted section of 2" diameter, Schedule 40 PVC pipe to obtain a ground-water sample. Water samples were collected with a Teflon bailer.

- Soil and ground-water samples were preserved in accordance with standard procedures.

- o All soil and ground-water samples were analyzed for the chemical parameters specified in the Statement of Work.

- o After all samples were collected, boreholes were backfilled with augered material and sealed with bentonite and neat cement. Excess soil and contaminated PVC screens were bagged for disposal by the Bioenvironmental Engineering office in accordance with the Statement of Work.

In addition to the seven project sites, three USGS monitor wells were sampled to provide background ground-water quality data. Locations of Phase II Stage 1 project sites and monitor wells are shown on Figure 3-1.

The boring locations and soil and ground-water sampling procedures are described in the following sections. The results of soil and ground-water analyses are given in Section 4.0. Lithologic descriptions of soil samples are reported in Appendix C. As noted, at all project sites, the boreholes were backfilled with soil, bentonite and neat cement, and excess cuttings were disposed by Bioenvironmental Engineering office personnel.

3.1 Sampling Procedures

During Phase II Stage 1 efforts at England AFB, soil and ground-water samples were collected by Radian personnel. A total of 96 soil samples were collected from 33 boreholes distributed among the seven project sites. One ground-water sample was collected from each project site plus one from each of three USGS monitor wells located along the base perimeter for a total of ten ground-water samples. Field sampling methodologies and equipment are described in the following sections.

3.1.1 Soil Sampling

Soil borings at each site were made using a manually advanced 3-1/4" diameter bucket-type auger. Borings were advanced to a maximum depth of ten

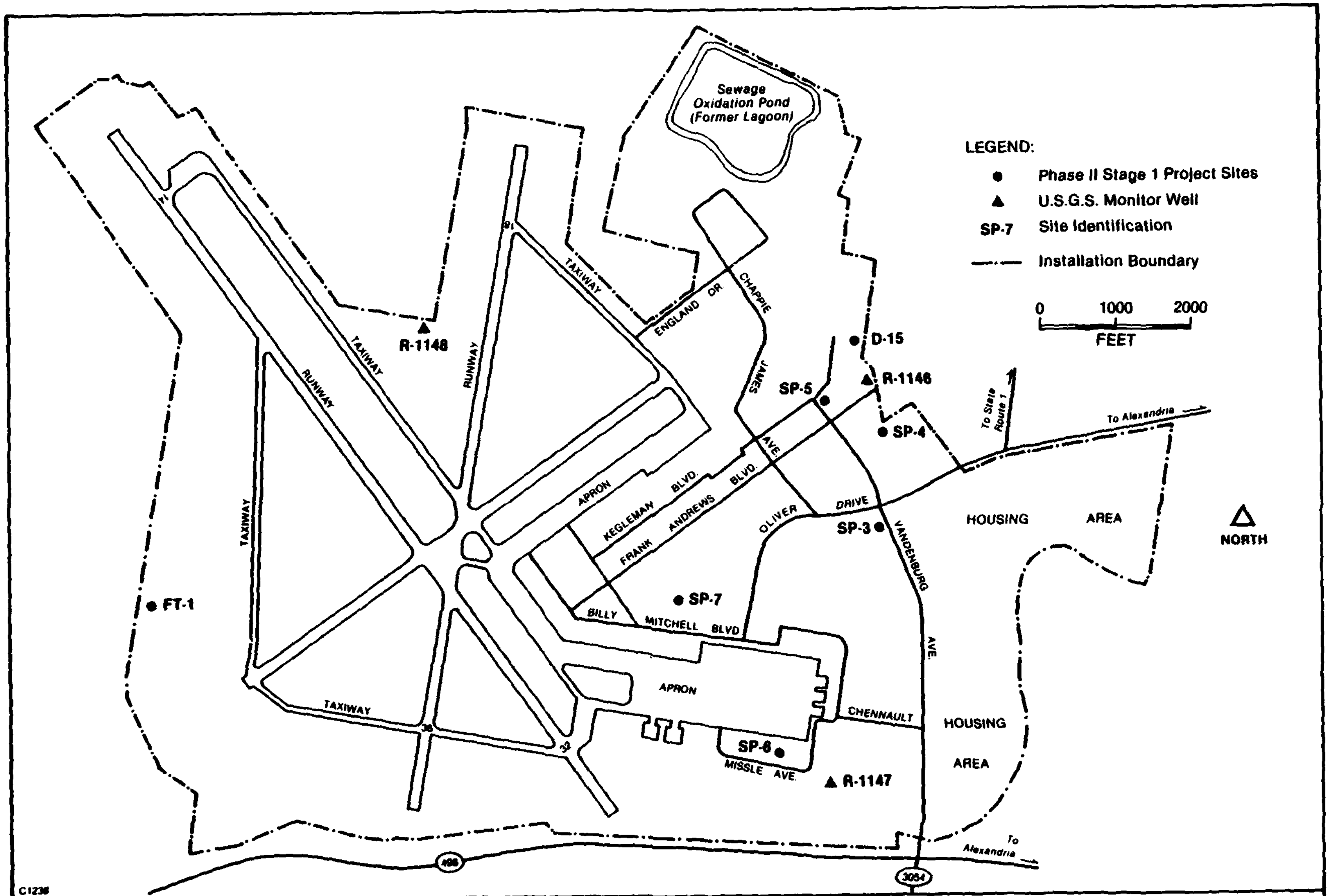

Figure 3-1. Locations of All Phase II Stage 1 Sampling Points, England AFB, Louisiana.

feet, or the first encounter with ground water, if shallower. As the boring was deepened, cuttings were removed from the borehole and temporarily held on a plastic tarp.

At each borehole location, grass, gravel, and other surface materials were removed and a surface soil sample was collected using a small trowel. Subsequent soil samples were obtained at 2.5 ft depth intervals using a 21" extendable soil probe. After each use, the probe was cleaned by first rinsing with water, washing with detergent, rinsing with acetone, and re-rinsing with distilled water. Soil samples were sealed in one-quart Mason jars and cooled on ice to 4°C prior to shipment to Radian for oil and grease analysis (IR).

3.1.2 Ground-Water Sampling

Ground-water was collected from one temporary well at each project site and three permanent USGS monitor wells using a one-liter Teflon ball valve bailer. Water samples for oil and grease analysis were transferred to one-quart Mason jars with Teflon-lined lids. Field measurements of temperature, pH, and conductivity were made on each sample. Samples were also collected in 40 ml glass vials with Teflon septa for analysis of EPA 602 compounds. Oil and grease samples were cooled on ice to 4°C and acidified to a pH<2 with H_2SO_4. EPA 602 samples were preserved by cooling to 4°C only. Following each use, the bailer was rinsed with water, washed with detergent, rinsed with acetone, and re-rinsed with distilled water.

3.1.3 Sample Analysis

All samples were shipped to Radian Analytical Services (RAS), Austin, Texas for analysis. Soil and water samples were analyzed for oil and grease by the infrared method (EPA Method 413.2). In addition, ground-water samples were analyzed by gas chromatography for volatile aromatic hydrocarbons using EPA Method 602 (see Table 1-3 for a listing of compounds).

Prior to oil and grease analysis of soils by the infrared method, samples underwent a four-hour period of extraction using freon as the extractant. Selected samples subsequently underwent 12-hour extraction periods based on preliminary data that suggested a longer duration was required for representative results. A detailed description of considerations that affected interpretation of the soils data is presented in Section 4.0.

3.1.4 Field QA/QC Procedures

Four sets of duplicate soil samples were collected to assess sample representativeness and precision of the analytical technique. Each of the duplicate one-foot core sections was split longitudinally into halves and stored in separate Mason jars.

Trip blanks of distilled water in 40 ml vials were carried to the field and accompanied samples throughout handling and shipping to detect any extraneous contamination. All QA/QC samples underwent the same preservation and handling procedures as the actual field samples.

As a final QA/QC precaution, chain-of-custody forms were executed for all samples (Appendix D).

3.2 Field Safety

The types of contaminants expected to be encountered during field activities at England AFB pose a minimal risk to personnel health or safety. Field personnel wore Tyvek coveralls and disposable latex gloves to prevent skin contact with potentially contaminated media. As a precaution, half-face respirators with organic cartridges were carried in the field but it was not deemed necessary that they be worn during routine sampling.

3.3 Surveying

Following completion of field activities, the horizontal locations of all borings were determined to the nearest 0.01 ft by surveying from a

permanent marker. A licensed land surveyor was subcontracted to accomplish this work. At the six sites where multiple boreholes were installed, a 24" iron stake was emplaced near the center of the site. The stake was located relative to a building or other permanent feature and borehole locations were determined relative to the reference stake. At site SP-5, where only one boring was made, the borehole location was determined directly as an azimuth direction and distance from the west corner of Building 2325. The surveyor's plats for each of the project sites are included in Appendix E of this report.

3.4 Site FT-1, Fire Training Site No. 1

Site FT-1 is located near the western installation boundary (Figure 3-1). From the early 1940's until 1964 the site was used as a fire training area. The site included a bermed area, approximately 100-ft in diameter, a drum storage area, and an old B-29 aircraft. The drum storage area was used to store 20 to 30 55-gallon drums of contaminated oils and sludges from refueling and aircraft maintenance. The drums, some of which were reportedly in poor condition, were stored directly on permeable soils. Aproximately twice each month, the waste materials were mixed with JP-4, placed in a tank within the bermed area and ignited. Protein foams were used to extinguish the fire (Engineering-Science, 1983).

3.4.1 Auger Boring Locations

A total of nine hand-augered boreholes were made at site FT-1. This number represents a deviation from the ten borings specified in the Statement of Work. The modification was made in order to install one additional boring at site D-15 (at the request of the Bioenvironmental Engineer), without changing the total number of boreholes authorized in the Delivery Order.

The locations of boreholes A through I are shown in Figure 3-2. Soil boring locations were selected with guidance provided in the pre-survey report and with the objective of covering the entire area of potential contamination, based on available data.

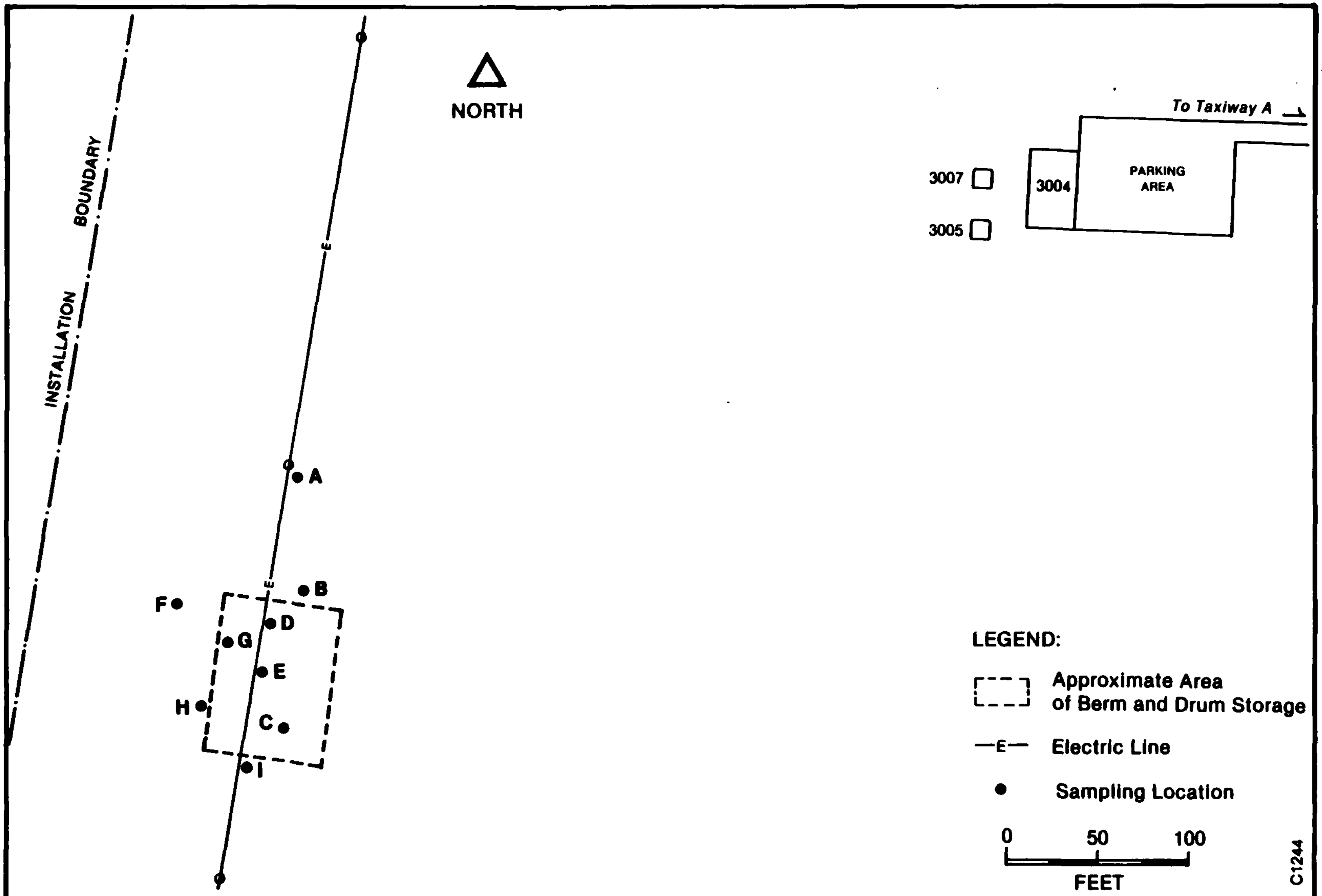

Figure 3-2. Phase II Stage 1 Sampling Locations, Site FT-1, Fire Training Area No. 1, England AFB, Louisiana.

3.4.2 Soil Sampling

For each boring, soil samples were collected at the surface and at 2.5 ft increments to the depth of first encounter with ground water or to a maximum depth of 10 ft, as required in the Statement of Work. A final soil sample was collected over the interval including the water table. Details of sampling procedures are presented in Section 3.1.1.

At site FT-1, ground water was generally encountered at a depth of 2 to 4 ft. A total of 22 soil samples were collected from the nine boreholes at this site on 29 February 1984. Generally, the site is overlain by surficial gravel, approximately three to four inches thick. The gravel is underlain by reddish-brown silts and clays which extend to the water table. All soil samples were analyzed for oil and grease by IR (EPA Method 413.2) as required by the Statement of Work.

3.4.3 Ground-Water Sampling

At site FT-1, borehole D was used to collect a ground-water sample for analysis of oil and grease and volatile aromatic hydrocarbon (EPA Method 602) compounds. A temporary casing of PVC pipe, slotted at the base, was installed in the borehole on 29 Febraury 1984. Water samples were collected on 3 March 1984; field measurements of temperature, pH, and conductivity were also taken at that time.

3.5 Site D-15, POL Sludge Weathering Pit

Site D-15 is located in the POL storage area near the eastern boundary of England AFB (Figure 3-1). From approximately 1955 until 1982, a small pit at this site was used to "weather" sludge from POL tank cleanouts. The pit was approximately two to four feet deep and covered an area of about 900 square feet. Reportedly, the ground-water level would often rise above the bottom of the pit. The site was covered with local soil in 1982 and regraded to surface contours.

3.5.1 Auger Boring Locations

A total of eleven hand-augered boreholes were made at site D-15. Nine borings were located in the immediate vicinity of the old sludge weathering pit. The other two borings were located in the gravel bed of the railroad spur and near a diesel fuel tank to assess the local impacts of fuel spills from routine operations.

The locations of boreholes A through K are shown in Figure 3-3. Soil boring locations in the pit area (A through I) were selected based on guidance provided in the pre-survey report. The remaining two boreholes (J and K) were located at sites specified by base personnel.

3.5.2 Soil Sampling

Soil samples were collected from each of the eleven boreholes at this site. Ground water was generally encountered at a depth of two to five feet. A total of 34 soil samples were collected on 1 March 1984.

Generally, the surface soils in the sludge weathering pit area are silty and organic-rich. They are underlain by dominantly silty to plastic clays with occasional sandy zones. Soils at the other two sampling sites are similar but include surficial gravel fill.

3.5.3 Ground-Water Sampling

At site D-15, borehole G was selected for ground-water sampling. The temporary PVC casing was installed on 1 March 1984, and water samples were collected on 4 March 1984 for oil and grease and volatile aromatic hydrocarbon analysis. Field measurements of temperature, pH, and conductivity were also made at that time.

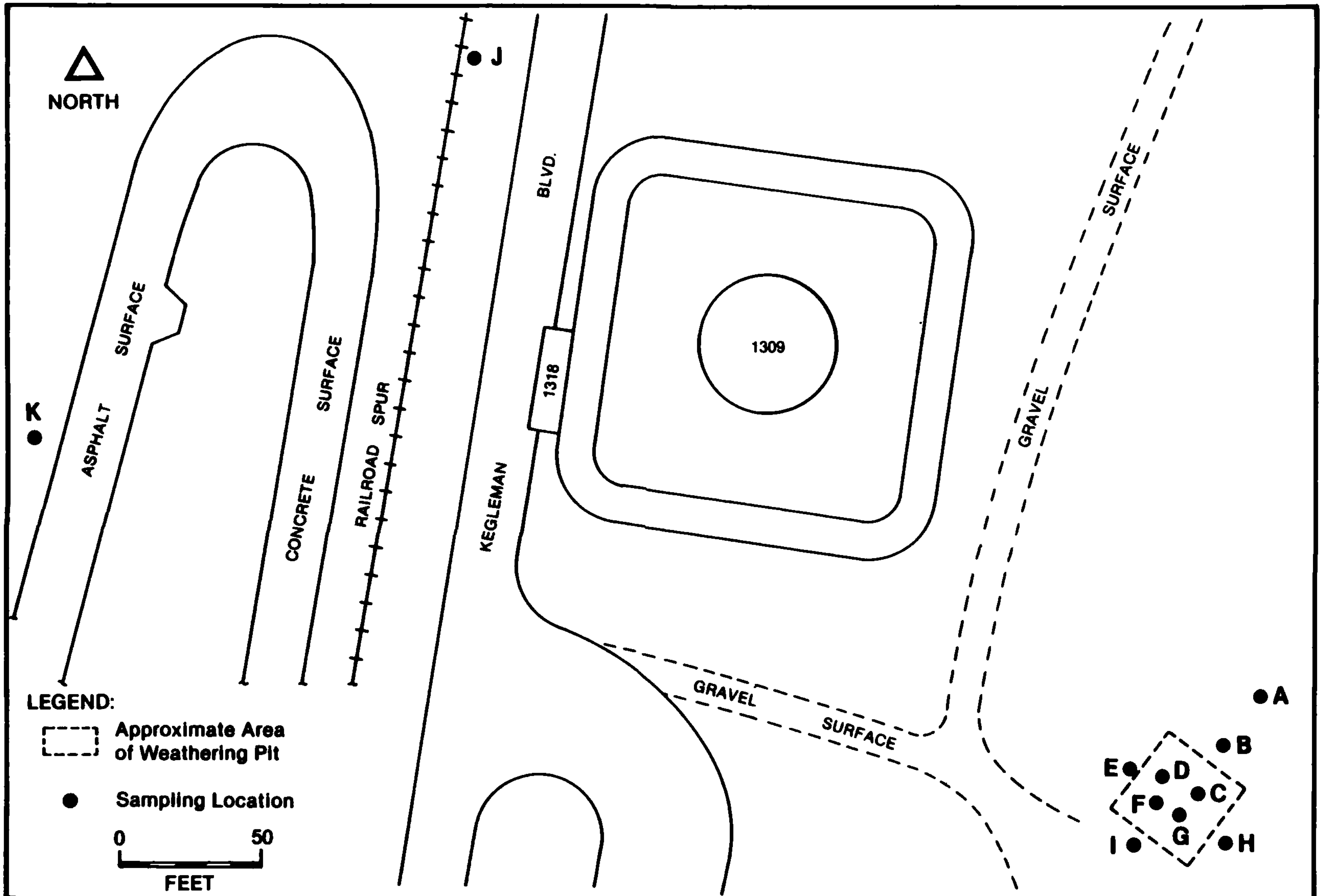

Figure 3-3. Phase II Stage 1 Sampling Locations, Site D-I5, POL Sludge Weathering Pit, England AFB, Louisiana.

3.6 Site SP-3, JP-4 Underground Line Leak

The SP-3 site is located near the Golf Course Clubhouse (Figure 3-1). In 1977 or 1978, a leak in an underground JP-4 line occurred at this site. An unknown quantity of JP-4 leaked into the soil and flowed into a nearby ditch. The fuel and saturated soil were collected and hauled to an area adjacent to site D-15 (POL Sludge Weathering Pit) for dewatering and disposal. A new line was installed in 1981.

3.6.1 Auger Boring Locations

A total of four auger borings were made at site SP-3. The locations of boreholes A through D are shown in Figure 3-4. Soil boring locations were selected with guidance from base personnel who knew the location of the former pipeline. Two borings were emplaced on each side of the drainage ditch into which the lost JP-4 reportedly flowed.

3.6.2 Soil Sampling

Soil samples were collected from each of the four boreholes at this site in the manner specified by the Statement of Work. Ground water was generally encountered at a depth of two to four feet. A total of nine soil samples were obtained from the four borings on 2 March 1984. Generally, the soils from this site are reddish-brown to gray-brown and consist of silty sands and clays.

3.6.3 Ground-Water Sampling

At site SP-3, borehole A was selected for ground-water sampling. The temporary PVC screen was installed on 2 March 1984 and the water samples for oil and grease and volatile aromatic hydrocarbon analyses were collected on 4 March 1984. Field measurements of ambient ground-water conditions were also made at the time of sampling.

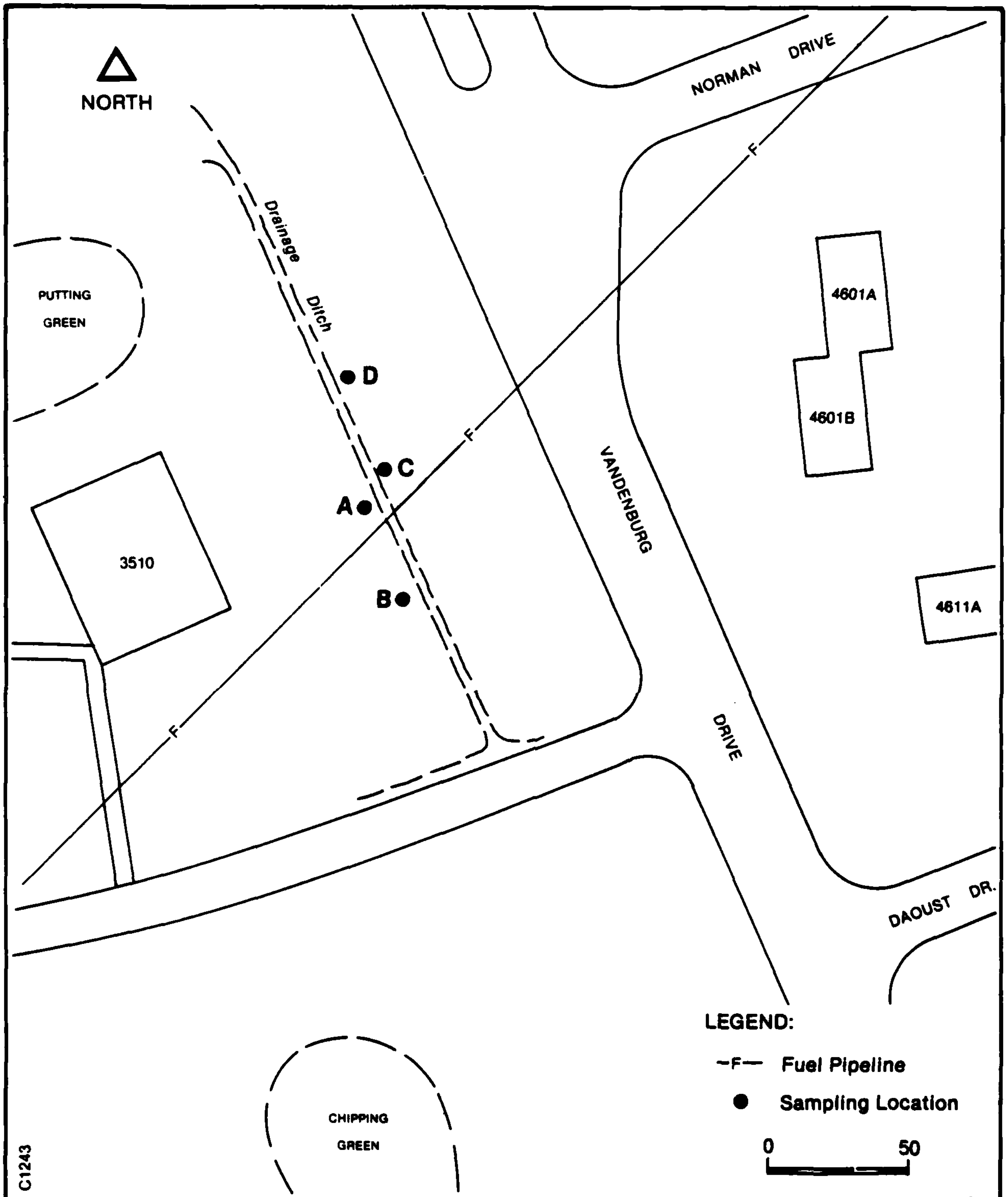

Figure 3-4. Phase II Stage 1 Sampling Locations, Site SP-3, JP-4 Underground Line Leak, England AFB, Louisiana.

3.7 Site SP-4, JP-4 Underground Line Leak

Site SP-4 is located near Building 1500 and the trailer park on the eastern edge of the base (Figure 3-1). During 1977-1978, a 1000 gallon JP-4 spill occurred as a result of an underground line break in this area. Part of the spilled JP-4 was recovered. Contaminated soil was excavated from site SP-4 and hauled to site D-15 for disposal.

3.7.1. Auger Boring Locations

Two boreholes were made at site SP-4. The locations of borings A and B are shown in Figure 3-5. Borehole locations were selected with guidance from base personnel who knew the location of the underground line.

3.7.2 Soil Sampling

Soil samples were collected from the two boreholes at this site in accordance with the requirements of the Statement of Work. Ground water was encountered at a depth between 2 and 3 feet. A total of four soil samples were collected from the two borings on 2 March 1984. Generally, the soils at this site consist of brown to reddish-brown silts and clays. Some admixed construction-type fill material was encountered between two and three feet deep.

3.7.3 Ground-Water Sampling

At site SP-4, borehole A was chosen for ground-water sampling. The temporary PVC screen was installed on 2 March 1984 and the water samples for oil and grease and volatile aromatic hydrocarbon analysis were collected on 4 March 1984. At that time, field measurements of ground-water temperature, pH and conductivity were also made.

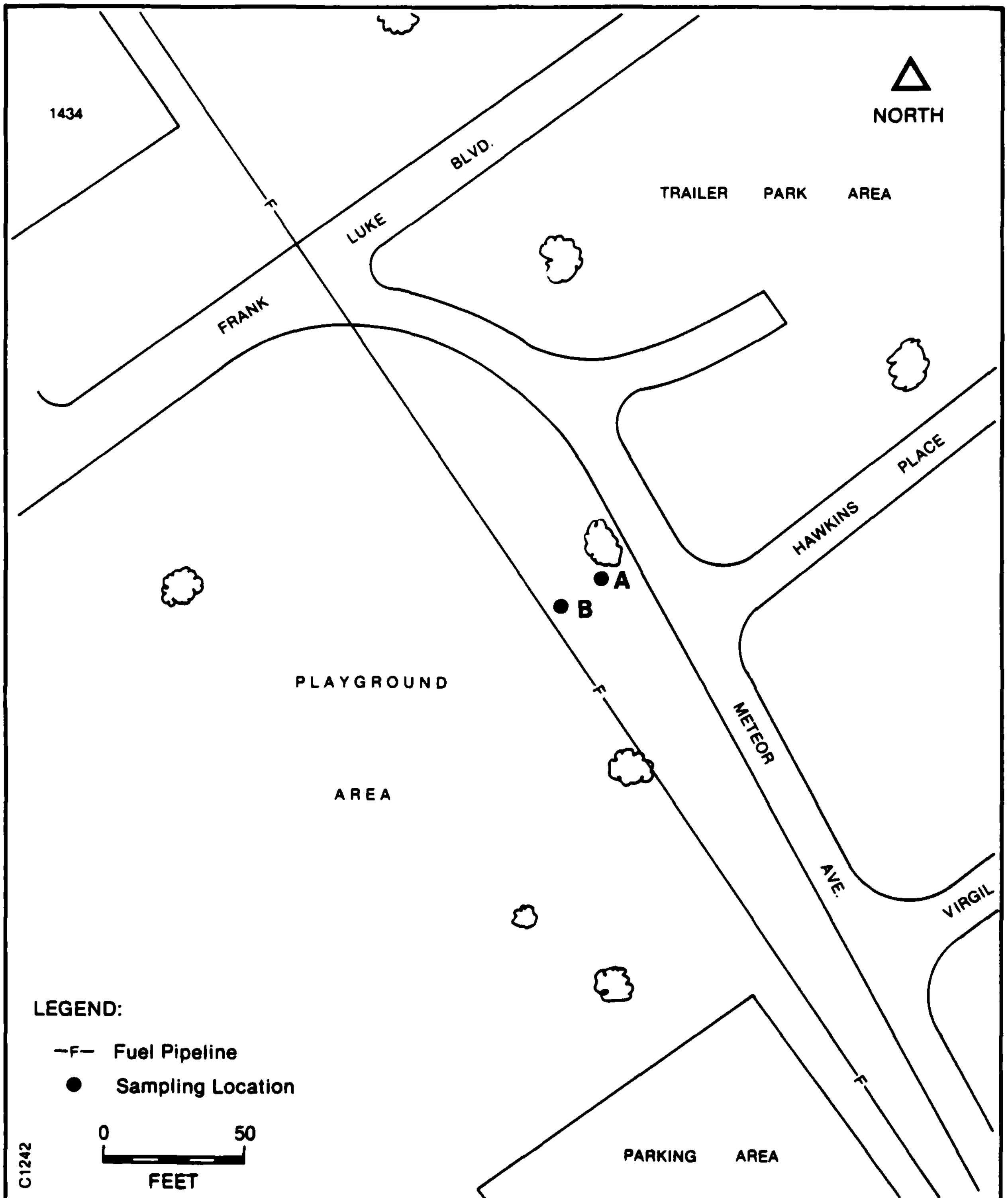

Figure 3-5. Phase II Stage 1 Sampling Locations, Site SP-4, JP-4 Underground Line Leak, England AFB, Louisiana.

3.8 Site SP-5, JP-4 Underground Line Leak

Site SP-5 is located near Building 2325 on the east side of England AFB (Figure 3-1). In 1981, a new JP-4 fuel line burst in this vicinity. Most contaminated soil was collected and hauled to site D-15, the POL Sludge Weathering Pit.

3.8.1 Auger Boring Location

A single borehole was emplaced at this site (A). Its location was selected with guidance from base personnel and is shown on Figure 3-6.

3.8.2 Soil Sampling

Three soil samples were collected from borehole A on 2 March 1984 in accordance with all requirements of the Statement of Work. Ground water was encountered at a depth of approximately 2.5 feet. The surface soil at this site consists of the typical reddish-brown silty clay found elsewhere on base to a depth of about 6". It is underlain by red plastic clay.

3.8.3 Ground-Water Sampling

After soil sampling at this site was completed, the borehole was fitted with a temporary PVC screen to collect ground-water samples for oil and grease, and volatile aromatic hydrocarbon analysis. The screen was emplaced on 2 March 1984 and water samples were collected the next day (3 March). Field measurements of water temperature, pH, and conductivity were also taken.

3.9 Site SP-6, CE Tank Spill

Site SP-6 is located near Building 2611 (Figure 3-1). It is the site of several suspected spill incidents from a 6000 gallon underground CE storage tank. This "slop tank", installed in 1972, is used by many of the shops as an accumulation point for waste oils. The tank is pumped out every

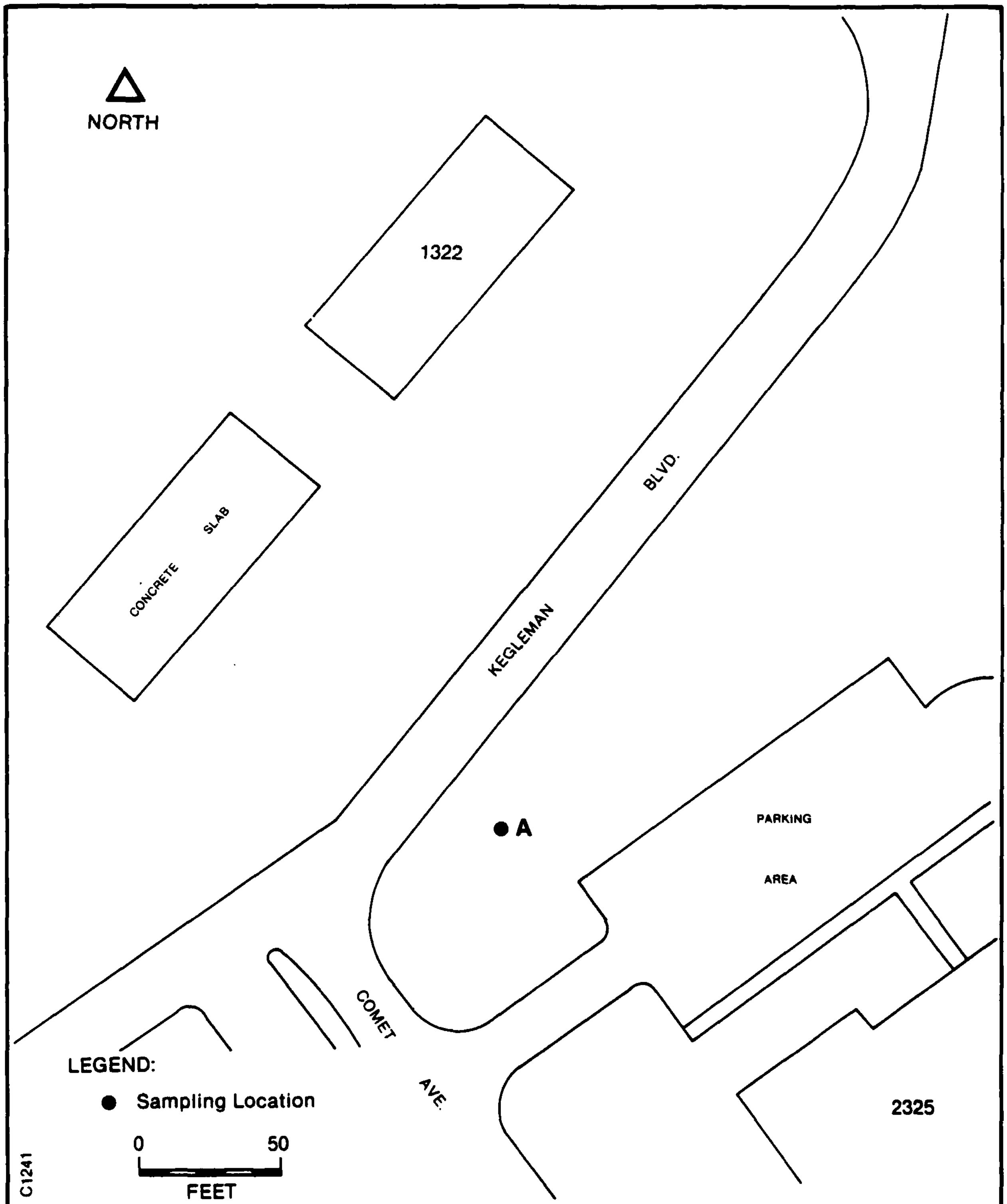

Figure 3-6. Phase II Stage 1 Sampling Location, Site SP-5, JP-4 Underground Line Leak, England AFB, Louisiana.

six months by a contractor who disposes of the wastes off-site at a permitted facility. Obvious discoloration of surrounding soil suggests that spills have occurred during loading and/or unloading of the tank.

3.9.1 Auger Boring Locations

Two boreholes were made at site SP-6. The locations of borings A and B are shown in Figure 3-7. Boreholes were located in areas of obvious soil discoloration above the underground tank.

3.9.2 Soil Sampling

Soil samples were collected from the two boreholes at this site, as required by the Statement of Work. Ground water was initially encountered at a depth of three to four feet on 29 February 1984. However, on 3 March, when the project team returned to collect the ground-water sample, the borehole (A) was dry. The temporary screen was pulled, and the borehole was deepened to ten feet. A total of eight soil samples were taken from boreholes A and B at this site.

Generally, site SP-6 is characterized by sandy silt surficial soils overlying silty plastic clays. The surface soils at the two boring locations are stained black with spilled fuel.

3.9.3 Ground-Water Sampling

At site SP-6, borehole A was selected for ground water sampling and temporarily cased with a PVC screen to a depth of 42" on 29 February 1984. As previously discussed, the water level had dropped below the bottom of the borehole by 3 March and the boring was deepened to 10 feet and re-screened. At a depth of 10 ft, the clays were saturated, but no free water was standing in the hole. By the following day (4 March 1984) a small volume of ground water had infiltrated the well and was collected for oil and grease and volatile aromatic hydrocarbon analysis. Field measurements of temperature, pH, and conductivity were also made.

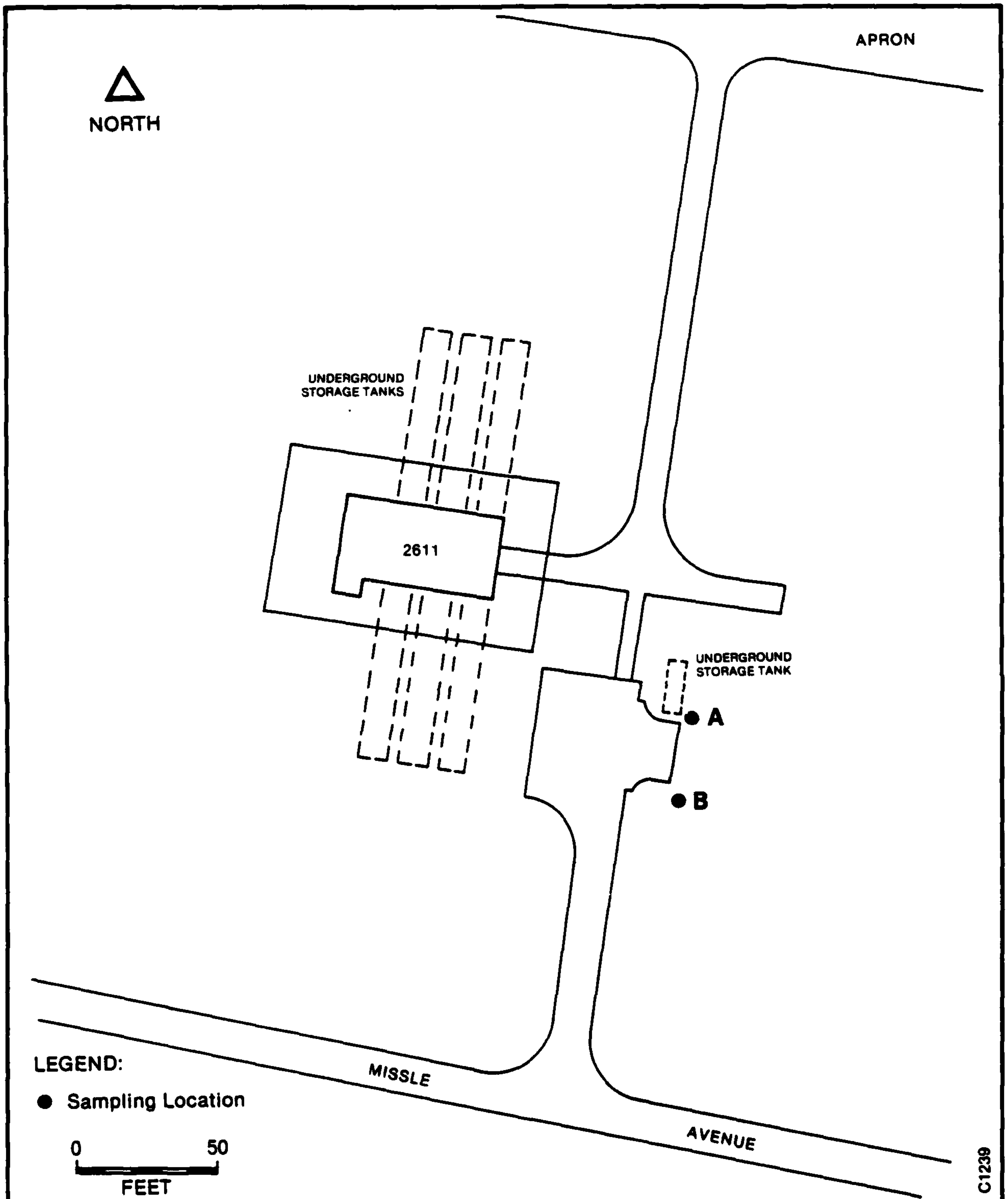

Figure 3-7. Phase II Stage 1 Sampling Locations, Site SP-6, CE Tank Spill, England AFB, Louisiana.

3.10 Site SP-7, MOGAS Underground Tank Leak

Site SP-7 is located near Building 2005, in the central part of England AFB (Figure 3-1). In 1977, a 10,000 gallon motor pool tank (MOGAS) suspected of leaking was removed. Although reportedly no evidence of leakage was observed when the tank was removed, visual evidence of contamination was noted during Phase II Stage 1 sampling in the area where the underground tanks were formerly located.

3.10.1 Auger Boring Locations

A total of four hand-augered boreholes were made at site SP-7. It was discovered that asphalt pavement is present beneath the surface soils at this site at a depth of approximately 4". Thus, the soil borings were distributed across the site in areas where the asphalt layer could be penetrated with the hand auger. The locations of boreholes A through D are shown in Figure 3-8.

3.10.2 Soil Sampling

Soil samples were collected from each of the four boreholes at this site as outlined in the Statement of Work. Across the site, ground water was encountered at depths varying from approximately 5 to 10 feet. A total of sixteen soil samples were collected from SP-7 on 2 March 1984.

The soils at this site are quite variable. The uppermost soil consists of clayey to silty sand which rests on a more-or-less continuous asphalt layer at a depth of about 4". Below the asphalt, clayey to gravelly sands, and coarse yellow sand interlayered with clay are encountered.

3.10.3 Ground-Water Sampling

At SP-7, borehole B was selected for ground-water sampling. The temporary screen was installed on 2 March and the water samples for oil and

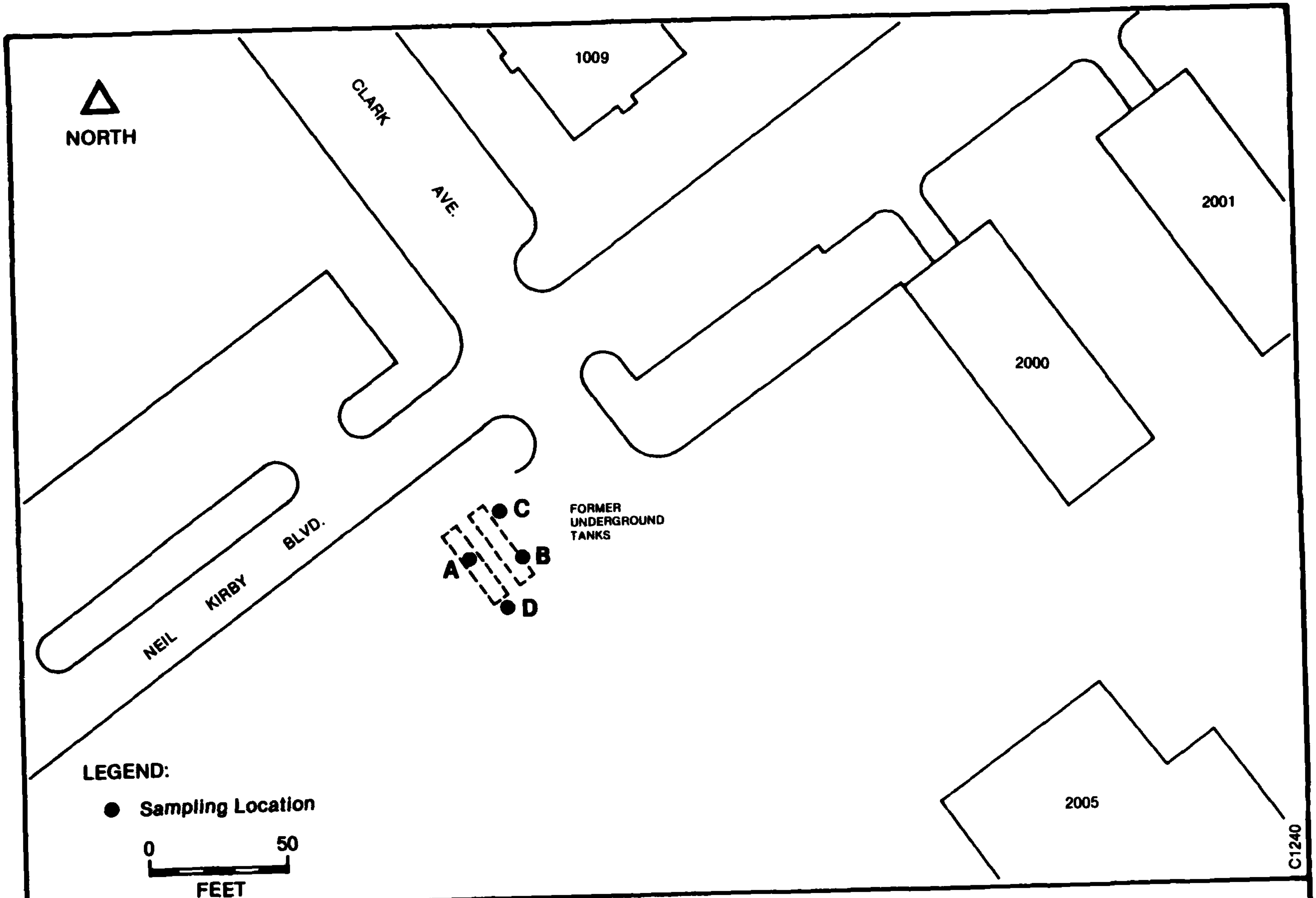

Figure 3-8. Phase II Stage 1 Sampling Locations, Site SP-7, MOGAS Underground Tank Leak, England AFB, Louisiana.

grease and volatile aromatic hydrocarbon analyses were collected on 4 March 1984. Field measurements of water temperature, pH, and conductivity were also made at that time.

3.11 USGS Monitor Well Sampling

As required by the Statement of Work, ground-water samples were collected from existing wells. Three USGS wells (R-1146, R-1147, and R-1148) that are located along the base perimeter and tap the shallow alluvial aquifer were sampled. The samples were analyzed for oil and grease and volatile aromatic hydrocarbons. A fourth well (R-1133), reportedly located just beyond the western base boundary, was not found. Figure 3-1 shows the locations of the USGS monitor wells.

Wells were purged of standing water prior to sampling by bailing 20 liters* from each. Field measurements of water temperature, pH, and conductivity were made on each sample.

3.12 Sampling Schedule

A total of 33 borings were sampled for soils, and 10 wells (including the seven temporary site wells) were sampled for ground water during Phase II Stage 1 field activities (27 February - 5 March 1984). The sampling schedule, including sample identification, sample type, date collected, date delivered to the laboratory, and analytical parameters are summarized in Appendix J.

*No well logs were provided for the three monitor wells prior to field sampling. Twenty liters was a volume selected in the field based on observations at the first monitor well, R-1148. Well R-1148 was bailed dry after 13 liters were removed but recovered rapidly. The remaining two wells were drawn down to a noticeble, but lesser extent upon removal of 20 liters of water.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

Soils and ground water were sampled at seven sites identified in the installation records search (Phase I) and pre-survey (Phase IIA) reports for England AFB. The distribution of sites and the locations of three USGS wells sampled for baseline water quality data are shown in Figure 4-1. Soils were analyzed for oil and grease using IR (EPA Method 413.2). Ground-water samples (one per site, plus one from each of three USGS monitor wells) were analyzed for oil and grease (IR), and for volatile aromatic hydrocarbons (EPA Method 602). A total of 96 soil and ten ground-water samples were analyzed. Raw data are provided in Appendix F.

Concentrations of oil and grease and EPA 602 compounds in ground-water samples are presented in Table 4-1. The monitor well values can be used to approximate background ground-water quality conditions. By comparison with ground-water analyses from each of the seven Phase II project sites, the impacts of past spills and waste management practices on local soils and on the shallow alluvial aquifer can be assessed.

Oil and grease extractions for soils were initially conducted for a period of four hours. Although no standard extraction time is specified in the EPA method, four hours is a sufficient period for the freon extractant to circulate through the soxhlet 12 to 16 times. Oil and grease concentrations in soils from Phase II Stage 1 sites after 4 hour extractions are presented in Tables 4-2 through 4-9. A preliminary review of these data revealed large variations in oil and grease concentrations between splits on several duplicate runs. Further review failed to identify any consistent trends in contaminant concentration that might be expected to occur either with depth in individual boreholes, or areally, on a site-wide basis. The question of the representativeness of the four hour extraction data was addressed by evaluating potential sources of analytical variability. These sources are described in Table 4-2.

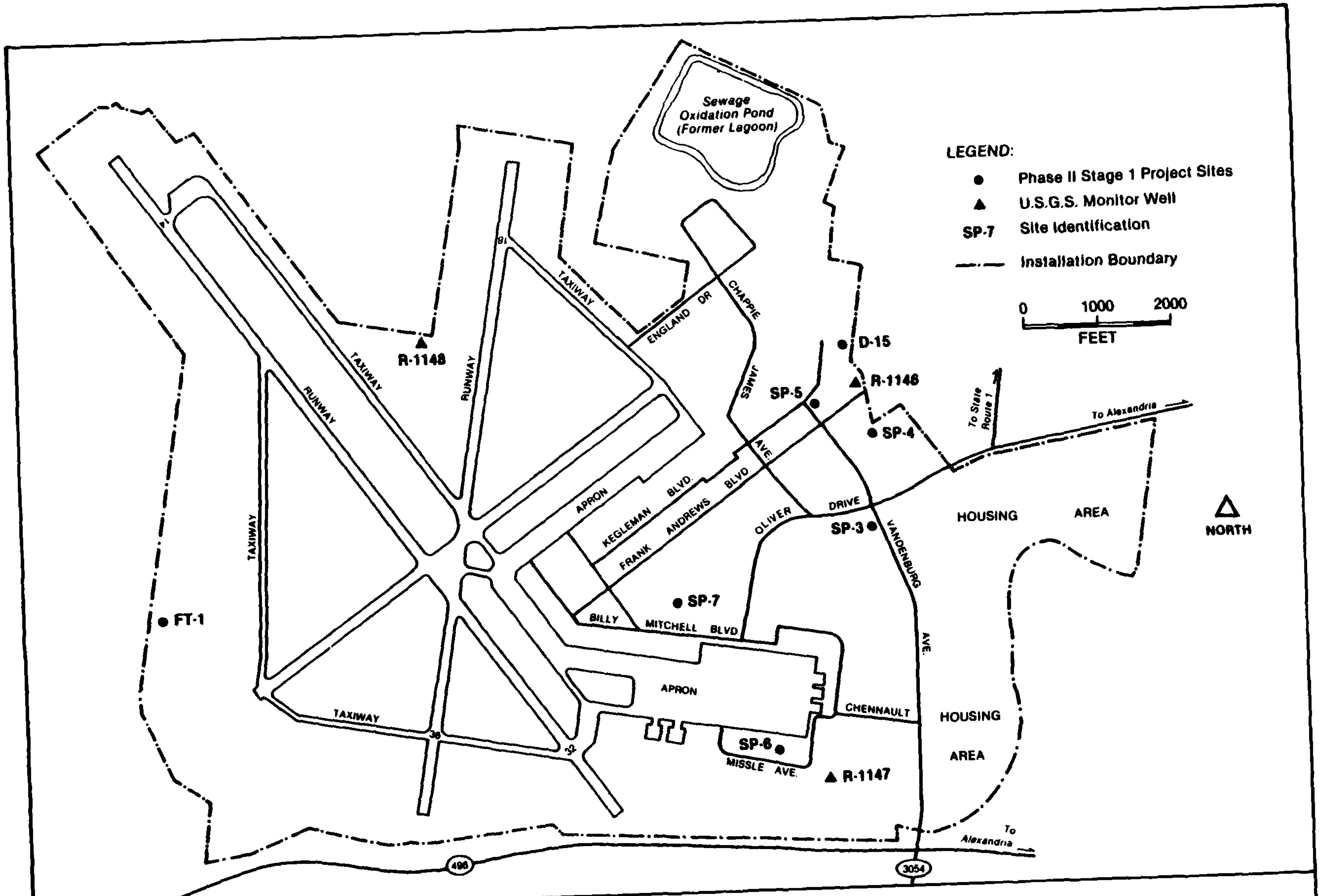

Figure 4-1. Locations of All Phase II Stage 1 Sampling Points, England AFB, Louisiana.

TABLE 4-1. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) AND EPA METHOD 602 (VOLATILE AROMATIC HYDROCARBON) ANALYSIS OF GROUND-WATER GRAB SAMPLES, ENGLAND AFB

Sample #	Oil and Grease (mg/L)	(μg/L) Benzene	Toluene	Ethyl Benzene	Dichlorobenzene 1,3-	1,2-	1,4-	T(°C)	pH	Conductivity (μmhos)
FT-1/D	6	125	ND	11	ND	ND	ND	14	6.5	1000
D-15/G	20	950	<5	290	<5	<5	<5	10.5	6.0	900
SP-3/A	7	2350	<50	ND	<50	<50	<50	10	6.0	900
SP-4/A	5	ND	ND	ND	ND	ND	ND	10.5	6.0	500
SP-5/A	6	ND	ND	ND	ND	ND	ND	11.5	6.0	645
SP-6/A	7	ND	26	ND	ND	ND	ND	13	6.5	900
SP-7/B	6	4200	8600	3900	<100	<100	<100	12.5	6.0	900
R-1146	4	ND	2	ND	ND	ND	ND	13	6.0	800
R-1147	5	ND	3	ND	ND	ND	ND	13.5	6.0	780
R-1148	4	ND	ND	ND	ND	ND	ND	12	6.0	300

NOTE: Detection limits for toluene and the dichlorobenzenes in samples D-15/G, SP-3/A and SP-7/B are higher than the method detection limits due to the presence of high concentrations of one or more of the other 602 compounds and/or interferences. This requires the samples to be diluted in order to quantify the high concentration compounds and results in raising the operational detection limits for compounds potentially present at lower levels.

TABLE 4-2. POTENTIAL SOURCES OF VARIABILITY IN EPA METHOD 413.2 ANALYSIS OF OIL AND GREASE IN SOILS

1) Sample inhomogeneity: Five replicate analyses run on sample SP-3 A-2 have a standard deviation of ± 18% and show a maximum deviation (difference between highest and lowest values) of 37.7%. This reflects both lithologic inhomogeneity and the resultant uneven distribution of oil and grease.

2) Limitations of the analytical technique: Spike recovery on lab QC run was 88%; i.e., 88% of a known quantity of Wesson oil was recovered from an artificially "contaminated" soil sample used to test the accuracy of the method. This level of accuracy is probably not attainable in the England samples considering the typical clay matrix and complexity of contaminants potentially present.

3) Duration of extraction time*: The first set of analyses was run using a 4 hour extraction time. Due primarily to the nature of the soil matrix (dominantly fine-grained silts and clay) and the difficulty in mobilizing oil and grease retained in this type of matrix through the soxhlet, a 4 hour extraction period may be too short to yield representative analyses for some samples.

4) Operator error.

*EPA 413.2 specifies no standard extraction time for soils.

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TABLE 4-3. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE FT-1, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
FT-1 A-1	S	1.2%
FT-1 A-2	2.5'	2900 ug/g
FT-1 A-3	5.0'	2800 ug/g
FT-1 B-1	S	1.5%
FT-1 B-2	2.5'	1900 ug/g
FT-1 C-1	S	2100 ug/g
FT-1 C-2	2.5'	3900 ug/g
FT-1 D-1	S	8200 ug/g
FT-1 D-2	2.5'	2600 ug/g
FT-1 D-3a	5.0'	3040 ug/g
FT-1 D-3b	5.0'	<10 ug/g
FT-1 E-1	S	1.4%
FT-1 E-2	2.5'	4200 ug/g
FT-1 F-1	S	5900 ug/g
FT-1 F-2a	2.5'	2900 ug/g
FT-1 F-2b	2.5'	<10 ug/g
FT-1 G-1	S	1800 ug/g
FT-1 G-2	2.5'	5400 ug/g
FT-1 H-1	S	9800 ug/g
FT-1 H-2	2.5'	3800 ug/g
FT-1 I-1	S	7700 ug/g
FT-1 I-1	2.5'	7300 ug/g

TABLE 4-4. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE D-15, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
D-15 A-1	S	5200 ug/g
D-15 A-2	2.5'	3400 ug/g
D-15 A-3	5.0'	1.5%
D-15 B-1	S	4.1%
D-15 B-2	2.5'	4800 ug/g
D-15 B-3	5.0'	1.8%
D-15 C-1	S	3.6%
D-15 C-2	2.5'	4.0%
D-15 C-3	5.0'	1.6%
D-15 D-1	S	2800 ug/g
D-15 D-2	2.5'	8500 ug/g
D-15 D-3a	5.0'	<10 ug/g
D-15 D-3b	5.0'	5300 ug/g
D-15 E-1	S	3800 ug/g
D-15 E-2	2.5'	2900 ug/g
D-15 E-3	5.0'	5300 ug/g
D-15 F-1	S	8800 ug/g
D-15 F-2	2.5'	4800 ug/g
D-15 F-3	5.0'	7200 ug/g
D-15 G-1	S	2000 ug/g
D-15 G-2	2.5'	910 ug/g
D-15 G-3	5.0'	920 ug/g
D-15 H-1	S	<10 ug/g
D-15 H-2	2.5'	<10 ug/g
D-15 H-3	5.0'	3400 ug/g
D-15 I-1	S	1800 ug/g
D-15 I-2	2.5'	<10 ug/g
D-15 I-3	5.0'	<10 ug/g
D-15 J-1	S	880 ug/g
D-15 J-2	2.5'	1200 ug/g
D-15 K-1	S	5500 ug/g
D-15 K-2a	2.5'	5800 ug/g
D-15 K-2b	2.5'	3800 ug/g
D-15 K-3	5.0'	5100 ug/g

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TABLE 4-5. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE SP-3, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
SP-3 A-1	S	9100 ug/g
SP-3 A-2	2.5'	5500 ug/g
SP-3 A-3	5.0'	5700 ug/g
SP-3 B-1	S	950 ug/g
SP-3 B-2	2.5'	2400 ug/g
SP-3 C-1	S	1.05%
SP-3 C-2	2.5'	1900 ug/g
SP-3 D-1	S	5300 ug/g
SP-3 D-2	2.5'	4400 ug/g

TABLE 4-6. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE SP-4, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
SP-4 A-1	S	<10 ug/g
SP-4 A-2	2.5'	6800 ug/g
SP-4 B-1	S	<10 ug/g
SP-4 B-2	2.5'	<10 ug/g

TABLE 4-7. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE SP-5, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
SP-5 A-1	S	<10 ug/g
SP-5 A-2	2.5'	560 ug/g
SP-5 A-3	5.0'	<10 ug/g

TABLE 4-8. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE SP-6, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
SP-6 A-1	S	5.4%
SP-6 A-2	2.5'	<10 ug/g
SP-6 A-3	45"-57"	820 ug/g
SP-6 A-4	7.5'	6400 ug/g
SP-6 A-5	10.0'	7900 ug/g
SP-6 B-1	S	1.5%
SP-6 B-2	2.5'	8000 ug/g
SP-6 B-3	5.0'	1.5%

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TABLE 4-9. SUMMARY OF EPA METHOD 413.2 (OIL AND GREASE) ANALYSIS OF SOILS, SITE SP-7, ENGLAND AFB

Sample #	Depth	Oil and Grease (IR) 4-Hour Extraction
SP-7 A-1	S	1.5%
SP-7 A-2	2.5'	8900 ug/g
SP-7 A-3	5.0'	7900 ug/g
SP-7 A-4	7.5'	1500 ug/g
SP-7 A-5	10.0'	4600 ug/g
SP-7 B-1	S	2700 ug/g
SP-7 B-2	2.5'	1400 ug/g
SP-7 B-3	5.0'	<10 ug/g
SP-7 B-4	7.5'	3.6%
SP-7 C-1	S	5200 ug/g
SP-7 C-2	2.5'	4000 ug/g
SP-7 C-3	5.0'	2600 ug/g
SP-7 D-1	S	1.7%
SP-7 D-2	2.5'	4940 ug/g
SP-7 D-3	5.0'	7.9%
SP-7 D-4	7.5'	1900 ug/g

The large variability in the analytical results is most likely due to a combination of these factors. The problem of the inhomogeneous distribution of contaminants is compounded by the clayey soil matrix and associated physical problem of mobilizing contaminants from such low permeability soils. Furthermore, EPA Method 413.2 is a screening technique in which all freon-extractable matter is reported as oil and grease. A significant portion of the variability in the analytical results could be related to natural organic sources (i.e. fulvics) which are interpreted as oil and grease by this method.

To evaluate the effect of extaction time, a subset of the original samples, including those samples with oil and grease concentrations of <2500 ug/g after a 4-hour extraction were re-run using an extended 12-hour extraction time. However, second run values deviate both positively and negatively from the originally determined values.* This suggests that the nature of the soil matrix and the influence of organic constituents are the most significant factors limiting the applicability of this technique on England AFB soils. In view of the foregoing discussion, it is concluded that oil and grease data from soils should be used only as a qualitative tool to assess environmental contamination.

4.1 Discussion of Results

In the following sections, hydrogeological observations and analytical data from ground-water and soil samples are discussed on a site-by-site basis.

4.1.1 Site FT-1, Fire Training Site No. 1

A total of nine auger borings (A through I) were made at site FT-1. From these, 34 soil samples, including two duplicate splits, were obtained.

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*Oil and grease data after 12-hour extractions are presented in Appendix K of this report.

The results of oil and grease analyses of all samples following 4-hour extractions are presented in Table 4-3. All of the soil samples are contaminated with heavy hydrocarbons. Within the limits of analytical certainty previously discussed, there appears to be a general trend of decreasing oil and grease contamination with depth. However, no areal trends are apparent across the site.

The oil and grease concentration (6 mg/L) in the grab water sample from borehole D at a depth of five feet does not differ notably from the background ground-water concentration measured in the USGS monitor well samples (range = 4 to 5 mg/L). However, benzene and ethyl benzene were identified at elevated levels.

4.1.2 Site D-15, POL Sludge Weathering Pit

A total of 11 auger borings (A thorugh K) were made at site D-15. Nine of the borings, represented by 28 soil samples, are located in the immediate vicinity of the weathering pit. Two additional soil samples were collected from borehole J located in the bed of the railroad spur that crosses the area, and four more samples (including one duplicate set) were collected near an on-site diesel fuel tank (borehole K). The results of oil and grease analyses of soil samples from D-15 are reported in Table 4-4.

All of the soil samples are contaminated with heavy hydrocarbons. Evaluation of data from boreholes A through I in the sludge weathering area shows no convincing depth-related trends in oil and grease concentration. The highest levels of oil and grease contamination are found in samples from boreholes C and B located respectively near the center and approximately down slope of the pit area.

The ground water sample from borehole G at a depth of 5 feet has an oil and grease concentration (20 mg/L) that is significantly above background values (4 to 5 mg/L). Benzene and ethyl benzene are also present at high levels.

4.1.3 Site SP-3, JP-4 Underground Line Leak

A total of four auger borings (A through D) were made at site SP-3. Nine soil samples were collected from these boreholes and analyzed for oil and grease. Analytical results are reported in Table 4-5.

Although no clear patterns in contaminant concentrations are apparent from the available soils data, generally the highest concentrations appear to lie along the trend of the failed pipeline (i.e., highest oil and grease concentrations occur in samples from boreholes A and C).

The oil and grease concentration in the grab ground-water sample from borehole A at a depth of 5 feet is of the same order of magnitude as the background samples. However, the benzene content is extremely high (2350 μg/L) relative to background.

4.1.4 Site SP-4, JP-4 Underground Line Leak

A total of four soil samples were collected from two boreholes (A and B) at SP-4. Oil and grease data after 4-hour extractions of all four samples are shown in Table 4-6.

These data must be considered highly suspect because of the large discrepancy between the three <10 μg/g values contrasted with the 6800 μg/g concentration reported in the A-2 sample. However, consistently low levels of oil and grease were found in the soil samples after the 12-hour extraction period (see Appendix K).

The oil and grease concentration in the ground-water sample from borehole A (5 mg/L) is in the same range as the background samples. No volatile aromatic hydrocarbons (EPA Method 602) were detected in the water sample.

4.1.5 Site SP-5, JP-4 Underground Line Leak

Three soil samples were collected from a single boring (A) made at SP-5. Oil and grease data after the 4-hour extractions are reported in Table 4-7. Very low levels of oil and grease were detected in the three soils after the 4-hour extraction period. Following a more lengthy extraction, a consistent concentration of 2000 μg/g was found in all samples (see 12-hour data, Appendix K).

The oil and grease concentration in the ground-water sample from 5 feet is not significantly different from background values. No volatile aromatic hydrocarbons (EPA Method 602) were detected in the water.

4.1.6 Site SP-6, CE Tank Spill

A total of eight soil samples were collected from two borings (A and B) made at site SP-6. Results of oil and grease analyses of the soils are reported in Table 4-8. No areal or depth-related patterns in soil contamination are discernable based on the available data. Discoloration of surface soils by spilled waste oil at both boring locations is reflected in the high oil and grease concentrations found in the surface samples.

The site ground-water sample was obtained from a depth of approximately 10 feet in borehole A. The oil and grease concentration in the sample was found to be only slightly above background levels. However, toluene (26 μg/L) was detected.

4.1.7 Site SP-7, MOGAS Underground Tank Leak

Sixteen soil samples were collected from four boring locations at this site. Results of oil and grease analyses of the soils are presented in Table 4-9. No site-wide trends in contaminant distribution are apparent. However, the analytical data generally support field observations, documenting chemical odor and/or visual evidence of contamination in distinct but discontinuous zones.

The site ground-water sample was obtained from borehole B at a depth of about 7.5 feet. The oil and grease concentration in the water sample is only slightly elevated relative to background levels. However, benzene, toluene, and ethyl benzene are present at highly elevated concentrations of 4200, 8600, and 3900 μg/L, respectively.

4.2 Significance of Findings

In the following sections, conclusions are drawn regarding the extent and significance of contamination identified in Phase II Stage 1 activities at England AFB. Ground-water data obtained from each of the project sites are compared to background conditions as defined by USGS monitor well samples. None of the soils collected during Phase II Stage 1 sampling can be unequivocally interpreted as defining background conditions. Additionally, the uncertainties associated with use of the oil and grease (IR) technique on the site-specific soils at England AFB (previously discussed) do not allow a quantitative interpretatin of resulting data. Therefore, oil and grease data from soils can only be used as a screening tool to indicate gross contamination.

4.2.1 Extent of Contamination

Based on the results of the Phase II Stage 1 field evaluation at England AFB, variable but generally high values of oil and grease in soils from five of the seven Phase II Stage 1 sites (FT-1, D-15, SP-3, SP-6, and SP-7) strongly suggest that extensive contamination has occurred. Samples from all boreholes at these sites contain oil and grease in quantities that are interpreted as higher than those which might normally be expected from natural organic sources alone. Therefore, a limit to the extent of soils contamination both areally and with depth cannot be defined based on existing data.

Data from the other two Phase II Stage 1 sites (SP-4 and SP-5) cannot be definitively interpreted without baseline data with which to compare them. The concentrations of oil and grease obtained in analysis of these soils are lower than at the other sites. However, due to the variability in the analysis and potential influence of natural organics (previously discussed), it cannot be conclusively determined that these samples are uncontaminated. As noted, data on the oil and grease content of soils can only be used qualitatively as indicators of contamination.

Analyses for volatile aromatic hydrocarbon (EPA Method 602) compounds and oil and grease (EPA Method 413.2) in a single ground water sample from each project site confirm the contamination suggested by the oil and grease data from soils at sites FT-1, D-15, SP-3, SP-6, and SP-7. EPA 602 data indicate that one or more volatile aromatic hydrocarbon compounds have migrated into the shallow ground-water system at levels requiring additional evaluation at these sites. Oil and grease contamination of ground water is suggested only at site D-15. However, based on only one water sample per site, no estimate of the extent of contaminant migration is possible.

4.2.2 Evaluation of Contamination

Because of the wide variety of compounds included in the category of oil and grease as defined by EPA Method 413.2, these generic data cannot be compared to specific regulatory standards. As previously discussed, it is highly unlikely that any soil samples collected from Phase II Stage 1 sites FT-1, D-15, SP-3, SP-6, and SP-7 are representative of background conditions. Oil and grease concentrations in soils from the remaining two project sites (SP-4 and SP-5) are relatively lower; however, it remains to be demonstrated that these soils are typical of background. Lacking background data, existing soils data can only be evaluated relative to one another. The sites are ranked in order of the highest oil and grease concentration observed in a single soil sample in Table 4-10.

TABLE 4-10. RANKING OF PHASE II STAGE 1 SITES BY HIGHEST SOIL CONCENTRATION OF OIL AND GREASE, ENGLAND AFB, LOUISIANA

Rank	Site #	Maximum Oil & Grease Concentration (IR)
1	SP-7	7.9%
2	SP-6	5.4%
3	D-15	4.1%
4	FT-1	1.5%
5	SP-3	1.05%
6	SP-4	6800 μg/g
7	SP-5	560 μg/g

To evaluate ground-water contamination, the oil and grease and volatile aromatic hydrocarbon concentrations in grab ground-water samples from each site were compared to levels found in USGS monitor well samples (R-1146, R-1147, and R-1148). These data are included in Table 4-1.

Toluene at a concentration of 2 to 3 μg/L is the only Method 602 compound detected in the background ground-water samples. The background oil and grease (Method 413.2) concentrations in the three monitor well samples varied from 4 to 5 mg/L.

Oil and grease concentrations in ground water samples from all project sites except D-15 are of the same order of magnitude (<10 mg/L) as those from the three USGS monitor wells. The sample from site D-15 has a significantly higher oil and grease value of 20 mg/L. Migration of oil and grease into the shallow alluvial aquifer may have occurred at site D-15, but is not demonstrated on the basis of existing oil and grease data at any of the other sites. At the other six sites, any contamination by heavier hydrocarbons, as indicated by oil and grease, appears to be retained within the soils of the unsaturated zone.

Toluene, at levels above background, and/or benzene and ethyl benzene were identified in ground-water samples from five Phase II project sites. These sites are ranked in order of total volatile aromatic hydrocarbon concentrations in Table 4-11.

TABLE 4-11. RANKING OF PHASE II STAGE 1 SITES WHERE VOLATILE AROMATIC HYDROCARBONS WERE DETECTED IN GROUND WATER BY TOTAL CONCENTRATIONS, ENGLAND AFB, LOUISIANA

		Concentrations of EPA Method 602 Compounds (µg/L)		
Rank	Site	Benzene	Toluene	Ethyl Benzene
1	SP-7	4200	8600	3900
2	SP-3	2350	<50	ND*
3	D-15	950	<5	290
4	FT-1	125	ND*	11
5	SP-6	ND*	26	ND*

*ND = not detected

Considering the questionable applicability of oil and grease analysis by IR to England AFB soils and the non-specific nature of the EPA Method 413.2 technique, the EPA Method 602 data from ground water grab samples appear to provide the most quantitative evaluation of contamination. On this basis, evaluation of contamination is limited to estimating the relative severity of contamination as indicated by the site rankings in Table 4-11. No evaluation of contaminant distribution in ground water is possible from existing data.

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5.0 ALTERNATIVE MEASURES

This section discusses the alternative measures available for actions at each of the sites investigated. As was discussed in Section 4.0, the occurrence of contaminants is significant primarily within the context of threats to a receptor. Alternative measures are considered as they relate to evaluating issues of exposure to candidate receptors. The potential receptors to be considered are the regional Miocene aquifer (sand members of the Fleming and Catahoula Formations) and the Red River.

The potential for contaminants present in the shallow ground water to migrate downward to the regional Miocene aquifer is very low. In the vicinity of England AFB the regional aquifer occurs at a minimum depth of approximately 120 feet. The normal pattern of ground-water flow is upward under force of artesian pressure into the overlying alluvial deposits. Only in areas where Miocene water levels have been seriously reduced by overpumping has local recharge from the overlying alluvial aquifer been reported.

Alluvial ground-water flow in the vicinity of England AFB is generally to the northeast. After crossing the base boundary, shallow ground water could potentially intercept the Red River and be discharged as base flow.

There are insufficient site-specific geologic data on the lithologically variable alluvial aquifer to predict with certainty whether contaminants from individual sites could impact the Red River. Considering the northeasterly flow direction, those project sites located on the east side of the base (D-15 and SP-3 through SP-7) have the closest proximity and therefore highest potential for off-site migration and impact on the Red River. The categories of alternative measures to be considered include:

- o Background soil sampling to evaluate the environmental significance of existing oil and grease data;

- o Collection of additional soil borings and grab water samples to define the areal extent and volume of contaminated materials;

- o Installation of downgradient monitor wells to define contaminant plume configuration and migration direction and rate;

- o Local surface water sampling; and

- o No additional activities.

5.1 Site FT-1, Fire Training Site No. 1

Analytical data obtained to date confirm soil and ground-water contamination with benzene, ethyl benzene, and toluene at FT-1. The extent of contamination cannot be determined on the basis of existing data. However, the site is located in a remote area of the base and the potential for off-site migration or hydralic interconnection with the underlying regional aquifer is low. The available alternative measures are:

- o Collect additional soil samples at increasing distances from the site to evaluate the volume and extent of contaminated materials;

- o Install monitor wells downgradient of the site to estimate plume configuration and rate of contaminant migration; or

- o Conduct no further investigation, based on the low risk of exposure by potential receptors.

5.2 Site D-15, POL Sludge Weathering Pit

Oil and grease contamination of soils, and contamination of ground water with oil and grease, benzene, and ethyl benzene at D-15 has been confirmed by analytical data obtained to date. The extent of contamination is however unknown. A small surface drainage is located immediately adjacent to the weathering pit area and iridescent slicks were observed on the surface. The apparent interconnection between the surface- and ground-water at this site provides an additional potential mechanism for off-site contaminant transport as the drainage ditch eventually discharges to Big Bayou. The available alternative measures are:

- o Collect additional soil samples to define the volume and extent of contaminated materials;
- o Install monitor wells downgradient of the site to estimate plume configuration and rate of migration; and/or
- o Collect surface water samples to evaluate this mechanism of contaminant transport.

5.3 Site SP-3, JP-4 Underground Line Leak

Analytical data confirm environmental contamination at SP-3. Soils show significant oil and grease contamination. Benzene is the primary volatile organic contaminant of concern in the ground water. The available alternative measures for this site are:

- o Install additional soil borings to define the volume and extent of contaminated materials; and/or
- o Install monitor wells downgradient of the site to estimate plume configuration and rate of migration.

5.4 Site SP-4, JP-4 Underground Line Leak

No volatile aromatic hydrocarbons were detected in the ground-water sample from this site and the oil and grease concentration is within the background range. Oil and grease were found in the site soil samples, but at relatively low levels. The available alternative measures are:

- o Collect background soil samples to evaluate the environmental significance of the oil and grease in site soils; or

- o Conduct no further investigations, based on the low concentrations of oil and grease in soil and water samples, the uncertainties associated with use of the IR method on lithologically inhomogeneous materials, and the absence of EPA Method 602 compounds from the ground water.

5.5 Site SP-5, JP-4 Underground Line Leak

The environmental conditions at this site are similar to those at site SP-4. The same two alternatives identified for that site (background soil sampling vs. no further activities) are also applicable here.

5.6 Site SP-6, CE Tank Spill

Oil and grease contamination of site soils and contamination of ground water with relatively low levels of toluene have been confirmed. Available alternative actions include:

- o Install additional soil borings to define the volume and areal extent of contaminated materials; and/or

- o Install monitor wells downgradient of the site to detect changes in water quality with time.

5.7 Site SP-7, MOGAS Underground Tank Leak

Analytical data obtained to date confirm significant oil and grease contamination of soils, and high concentrations of benzene (4200 ug/L), ethyl benzene (3900 ug/L), and toluene (8600 ug/L) in the ground water from this site. The entire site is covered by a thin veneer (about 4") of soil which overlies an essentially intact asphalt surface. The available alternative measures for this site are:

- Collect soil samples to determine the volume and extent of contaminated materials; and/or

- Install monitor wells downgradient of the site to estimate contaminant plume distribution and rate of migration.

6.0 RECOMMENDATIONS

In this section, Phase II Stage 1 project sites are categorized on the basis of the adequacy of existing data for assessment of environmental impact, and the conclusions drawn from those data. Category I includes those sites where no further action (including remedial action) is required. Data for these sites are considered sufffficient to rule out unacceptable health or environmental risks. Category II sites are those requiring additional monitoring or work to quantify or further assess the extent of current or future contamination. Category III sites are sites that require remedial actions and are ready for IRP Phase IV actions.

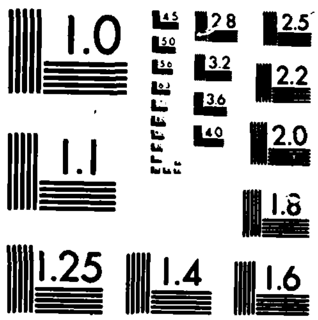
All of the sites investigated in the Phase II Stage 1 study at England AFB belong to Category II. For each site, existing data are insufficient either: 1) to delineate the full extent of documented contamination associated with the site, or 2) to unequivocally demonstrate that the site poses no unacceptable health or environmental risks.

In this section, project sites are prioritized on the basis of the significance of environmental impacts and risk of off-site contaminant migration, as interpreted from all available data. Radian's recommendations for additional stages of Phase II activities, selected from the site-specific alternatives outlined in the preceding section, are developed. The rational for Radian's recommendations is summarized from the information presented in Section 4.0. Additional recommendations made by EPA are identified as such and are discussed for the appropriate sites. Non-site-specific recommendations are presented in Section 6.5.

6.1 Site SP-7 (MOGAS Underground Tank Leak)

Install a minimum of three downgradient monitor wells to a depth of 10 ft below the local water table in the vicinity of SP-7. Monitor wells should be sampled quarterly and analyzed for EPA Method 602 compounds, and analyzed at least annually for oil and grease.

AD-A165 044 INSTALLATION RESTORATION PROGRAM PHASE II 2/3
CONFIRMATION/QUALIFICATION STAGE 1 FOR ENGLAND AFB
LOUISIANA(U) RADIAN CORP AUSTIN TX G D SWOBODA NOV 85
UNCLASSIFIED RAD-212-027-10 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Ground-water samples from this site have the highest concentrations of volatile aromatic hydrocarbons identified in this stage of investigation. Soil samples are also significantly contaminated with oil and grease; however, the levels in ground water are only slightly above background at this time.

EPA recommends soil sampling and analysis for volatile and semi-volatile organics using EPA Methods 8240 and 8250. They suggest using EPA 624/625 instead of EPA 602 to provide identification of a broader range of potential contaminants. Resultant data would be used to evaluate any immediate threat to human health posed by the site.

6.2 Site D-15 (POL Sludge Weathering Pit) and Site SP-3 (JP-4 Underground Line Leak)

6.2.1 Site D-15 (POL Sludge Weathering Pit)

Install a minimum of three downgradient monitor wells to a depth of 10 ft below the local water table in the vicinity of D-15. Wells should be sampled quarterly. Surface water samples should be obtained in spring and winter from the drainage ditch at a point adjacent to the site and at a second point where the ditch discharges into Big Bayou. All samples should be analyzed for EPA Method 602 compounds and for oil and grease.

Ground water from this site has the highest oil and grease concentration found anywhere on base. At 20 mg/L, this level is almost five times the average background concentration. Benzene was also identified at relatively high levels, and site soils include variable, but generally significant concentrations of oil and grease. Finally, the observed connection between ground- and surface water at this site is the basis for the recommended surface water sampling.

EPA makes the same supplemental recommendations for this site as for SP-7 (Section 6.1). Additionally, EPA suggests surface water and sediment

sampling in the drainage ditch adjacent to site D-15 for analysis of volatile and semi-volatile organics.

6.2.2 Site SP-3 (JP-4 Underground Line Leak)

The recommendations for additional activities are the same as those for site SP-7. Significant levels of benzene, and concentrations of oil and grease which are somewhat higher than background levels were identified in the site ground-water sample. Site soil samples also show significant levels of oil and grease.

EPA makes the same supplemental recommendations for this site as for SP-7 (Section 6.1).

6.3 Site FT-1 (Fire Training Area No. 1) and Site SP-6 (CE Tank Spill)

6.3.1 Site FT-1 (Fire Training Area No. 1)

Install five to six additional soil borings in the downgradient direction, beyond those emplaced in the first stage of field sampling. Collect soil samples at 2.5 ft intervals to the water table or to a maximum depth of 10 ft. Also collect grab water samples from at least two of the borings fitted with temporary PVC screens. Analyze all soil and ground-water samples for EPA Method 602 compounds.

The main purpose of the recommended actions is to determine the extent of contamination at this site. Even though benzene was detected at significant levels in the ground-water sample, the site is remote and the potential risk to receptors is low as contaminant migration is not extensive. Therefore, limited additional activities are proposed, utilizing a phased approach to better define the potential impact of this site. If high contaminant levels are found in the proposed samples, installation of monitor wells may be indicated.

EPA makes the same supplemental recommendations for this site as for SP-7 (Section 6.1). EPA also recommends further study to determine the ground-water flow direction at the site in order to assess the potential for contaminant migration toward Rapides Bayou.

6.3.2 Site SP-6 (CE Tank Spill)

Install one downgradient monitor well and sample ground water semi-annually for EPA Method 602 compounds and annually for oil and grease.

Soil samples are contaminated with oil and grease, however, ground-water concentrations are only slightly above background levels. The only volatile aromatic hydrocarbon species detected in the ground water is toluene and it is present at only slightly elevated levels relative to background. Therefore, most contaminants appear to be retained in the soils and only a minimal ground-water monitorng program is recommended at this time.

EPA makes the same supplemental recommendations for this site as for SP-7 (Section 6.1).

6.4 Sites SP-4 and SP-5 (JP-4 Underground Line Leaks)

Collect background soil samples at 2.5 ft intervals to a maximum depth of 10 ft from one borehole located near one of the USGS monitor wells. Analyze soil samples for oil and grease by IR (EPA Method 413.2). Compare these results to existing soils data from sites SP-4 and SP-5 to interpret the environmental significance of oil and grease concentrations in soils at these two sites.

No volatile aromatic compounds were detected in ground-water samples from either site and oil and grease levels in ground-water samples were near background concentrations from the USGS monitor wells. Oil and grease were detected in soils from both sites, but at levels significantly lower than at

the other five project sites. The limited actions recommended could confirm the likelihood that neither site SP-4 nor SP-5 poses a threat to human health or the environment.

EPA suggests additional soil sampling and analysis for volatile organics at these two sites.

6.5 Non-Site-Specific Recommendations

The following recommendations for Phase II Stage 2 activities are not specific to individual Phase II Stage 1 sites. They are designed to aid in interpretation of base-wide data and potential environmental impacts:

- Reassess potential impacts from Phase I sites receiving intermediate HARM scores, but not included in the Phase II Stage 1 study. Conversations with England AFB and OEHL personnel suggest that some of these sites, and possibly others not identified in the Phase I study, may require field confirmation/quantification of potential environmental impacts.

- Include monitoring of USGS well R-1146 in the Phase II Stage 2 program to serve as an indication of any off-base contaminant migration. Wells R-1147 and R-1148 should also be considered for inclusion, depending on the selection of new monitor well sites.

- Locate or install wells and monitor shallow ground-water quality at several off-base, down-gradient locations and at least one up-gradient site.

- Document seasonal water table elevations.

- o Establish upstream and downstream surface water sampling stations on the Red River in the vicinity of the base.

- o EPA recommends that consideration be given to sampling the Miocene aquifer to verify the absence of contamination. The rationale is that the Miocene aquifer provides the primary drinking water supply in the area. Lack of contamination in this aquifer has been assumed due to its depth (120 feet). However, the report notes two processes, faulting and concentrated pumpage, by which migration from the contaminated alluvial aquifer to the Miocene aquifer could occur.

- o EPA recommends that ground-water flow directions beneath England AFB need to be determined in order to accurately assess migration of contaminated ground water.

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APPENDIX A

Resumes of Key Personnel

MARSHALL F. CONOVER, P.E.

EDUCATION:

Graduate Studies, University of California, San Diego, CA.

B.A., Physics, San Diego State University, San Diego, CA, 1963.

PROFESSIONAL EXPERIENCE:

Senior Program Manager, Radian Corporation, 1977-Present.

Assistant Project Manager, TRW Systems Group, 1968-1977.

Group Leader, Grumman Corporation, 1965-1968.

Sr. Flight Test Engineer, General Dynamics, 1958-1965.

FIELDS OF EXPERIENCE:

Mr. Conover is a Program Manager in the Research and Engineering Operations at Radian. He develops new business and manages contracted projects that provide technical multidisciplinary services in failure analysis, research, engineering, corrosion, alternate energy, and energy conservation.

In activities for the electric power industry, Mr. Conover has been responsible for many failure analyses of operational and R&D power plant components.

Mr. Conover has managed many corrosion-related studies of geothermal power plants for SDG&E, Heber, CA; DOE, Raft River, ID; a utility consortium in Nevada, and Hawaii Electric, Puna, HI. In addition, Mr. Conover has also directed several EPA projects aimed at determining the energy costs and plant effluents resulting from more stringent national standards for sulfur dioxide emissions from steam-electric power plants.

For five years Mr. Conover has been responsible for a DOE project to determine materials selection guidelines for geothermal power plants. From detailed analyses, the concept of site-specific corrosion phenomena was reduced to an emperical concept that all geothermal resources fit into six corrosivity classes.

Prior to joining Radian Corporation, Mr. Conover performed consulting engineering in the United States Energy Research and Development Administration's Office for Fossil Energy Development. In various senior project positions, Mr. Conover conferred with Fossil Energy Project Offices to establish their annual plans for coal liquefaction and gasification, magnetohydrodynamics (MHD), demonstration plants, advanced research, enhanced oil and gas recovery, and in-situ oil shale and coal gasification technologies. In addition, Mr. Conover played a central role in formulating ERDA's plans for developing natural gas resources from the Western tight gas sands and eastern gas shales.

As Fleet Command Support Center (FCSC) Assistant Project Manager for Site Engineering, Mr. Conover was responsible for Field Offices at the London, Norfolk, Honolulu, and Pentagon Command Centers (CC) as well as a support office at the customer's offices in Arlington, VA.

For the Space Shuttle, Mr. Conover was responsible for payload accommodation/interfaces, technical marketing pursuits and studies. Also responsible for Shuttle/payload carrier computer interface work, Mr. Conover's major concerns included requirements for implementation of process auditing, function allocation coordination, requirements compliance and system design assessments, and panel/working group participation. He served as Lead Experiments Engineer for a project that produced the Skylab Experiments Operational Data Book. Mr. Conover also organized and staffed a Data Engineering Group which was responsible for the data systems and reporting of the Apollo Lunar Module (LM) thermal-vacuum mission simulation testing at NASA/Johnson Space Center.

For a wide range of Atlas Space Launch Vehicle payloads, Mr. Conover was responsible for the flight test evaluations and reports. Extensive failure analyses were conducted using instrumentation/telemetry data, photographic data and laboratory simulations.

PROFESSIONAL ACTIVITIES:

- Associate Fellow, AIAA, 1970-1974
- Geothermal Resources Council, 1978-1983
- Texas Solar Energy Society, 1979
- ASTM, E45.3, Subcommittee Chairman, 1980
- ASHRAE, TC 6.8, Research Subcommittee Chairman, 1982

LICENSE:

Registered Professional Engineer: Texas - SN 33369.

THOMAS W. GRIMSHAW

EDUCATION:

Ph.D., Geology, University of Texas at Austin, 1976.

M.S., Geology, University of Texas at Austin, 1970.

B.S., Geological Engineering, South Dakota School of Mines and Technology, 1967.

EXPERIENCE:

Division Manager, Policy and Environmental Analysis Division, Radian Corporation, Austin, TX, 1982-Present.

Department Head, Environmental Analysis Department, Radian Corporation, 1978-1982.

Group Leader, Radian Corporation, 1976-1978.

Teaching Assistant, the University of Texas at Austin, 1974.

Captain (R&D Coordinator), U.S. Army, 1970-1972.

Geologist, Junior Grade, Amoco Production Company, 1969-1970.

Geologic Field Assistant, Amoco Production Company, 1967.

Certification: AIPG Certified Professional Geologist No. 4425

FIELDS OF EXPERIENCE:

As Program Manager at Radian, Dr. Grimshaw has overall responsibility for the technical, fiscal, and scheduling aspects of numerous solid/hazardous waste, ground water and other environmental projects. He serves as the primary point of contact for the clients sponsoring the work. Dr. Grimshaw is also responsible for marketing and preparing proposals for Radian services in a variety of areas, including solid/hazardous waste site investigations, remedial action planning and implementation, ground-water contamination studies, multidisciplinary environmental studies, and reclamation investigations.

Most recently, Dr. Grimshaw has served as Program Manager (PM) for ten of the U.S. Air Force, IRP Phase II investigations. These projects, which are being performed for the USAF Occupational and Environmental Health Laboratory, Brooks AFB, Texas are an integral part of the Air Force Installation Restoration Program, Phase II.

Also for the Air Force, Dr. Grimshaw is PM for wastewater investigations at Kelly AFB and Laughlin AFB, Texas.

For a major law firm in Kansas City, Missouri, Dr. Grimshaw is serving as PM for a program to provide Expert Witness and corollary services related to a hazardous waste disposal site in Kansas City. Expert support is also being provided for oversight of remedial investigation and feasibility study activities by the U.S. EPA and the RP generators.

Dr. Grimshaw is PM for a site investigation and remediation for a pesticide contaminated site in Arizona. This project has included soil sampling and analysis for pesticides, remedial plan preparation, and presentations to state and EPA regulatory authorities.

For Tuloma Energies, Inc., Dr Grimshaw directed development of a commercial Hazardous Waste Management Facility in northeastern Oklahoma. Dr. Grimshaw assisted Tuloma Energies in coordination with the Oklahoma Department of Health during the initial phases of the project.

HONORARY AND PROFESSIONAL SOCIETIES:

Sigma Xi, Phi Kappa Phi, Sigma Tau, Sigma Gamma Epsilon, Geological Society of America, American Association of Petroleum Geologists, Association of Engineering Geologists.

DEBRA L. RICHMANN

EDUCATION:

M.A., Geology, University of Texas at Austin, 1977.

B.A., Geology, University of Minnesota, 1974.

EXPERIENCE:

Staff Geologist, Radian Corporation, Austin, TX, 1981-Present.

Research Scientist Associate II, Bureau of Economic Geology, University of Texas at Austin, 1979-1981.

Technical Research Assistant, American Petroleum Institute, 1976-1979.

Research Assistant, Bureau of Economic Geology, University of Texas at Austin, 1976.

Teaching Assistant, Department of Geological Sciences, University of Texas at Austin, 1974-1976.

FIELDS OF EXPERIENCE:

Project Director for U.S. Air Force Installation Restoration Program (IRP) Phase II Stage 1 Field Confirmation at England AFB, Louisiana. Project activities included soil and ground-water sampling and analysis to determine the extent of potential environmental contamination at suspect sites.

Project Director for U.S. Air Force IRP Phase I Records Search at Reese AFB, Texas. Project activities for Phase I of the IRP include review of available data and interviews with former and present base personnel and regulatory officials to determi- if past waste management practices have resulted in potential environmental contamination. Phase I culminates with a report that identifies sites determined to pose a significant potential risk to human health or the environment and provides recommendations for Phase II studies.

Supervising geologist for reconnaissance boring and/or monitor well installation during IRP Phase II studies at Kelly AFB, Texas; McClellan AFB, California; and Cannon AFB, New Mexico.

Project Director for an environmental scoping study at an inactive Cu-smelter site near Salt Lake City, Utah. The site is being considered for proposed inclusion on the Superfund NPL due to the presence of stockpiled slag on-site and the potential for leachate generation and off-site migration of toxic components. Field activities included soil and shallow ground-water sampling.

Hydrogeology Task Leader for a study funded by EPA to develop guidance for closure and remedial action at hazardous waste surface impoundments used in

the wood treating industry in Florida. Project activities included analyzing the complex regional combinations of hydrogeology, geology, soils, and surface-water hydrology. Based on this analysis, treatment technologies and costs were developed for disposal of liquids, sludges, and contaminated soils in the various regions.

Project team member conducting field sampling to assess potential ground-water contamination of a shallow aquifer associated with an active waste disposal site in Andover, Minnesota. Also, wells were tested to determine local hydraulic conductivity of the aquifer.

Project team member in an EPA Region V Superfund study which included ground-water sampling efforts in the vicinity of an inactive coal-tar distillation and wood preserving facility in St. Louis Park, Minnesota. Project activities include selecting sampling locations and collecting samples to determine the type and extent of ground-water contamination associated with the uncontrolled release of creosote from the facility.

As a Technical Research Assistant with the American Petroleum Institute, Ms. Richmann's responsibilities included assembling technical data and preparing reports on behalf of the petroleum industry. Major areas of involvement included federal regulations governing petroleum exploration and production on Public Lands, and following developments in the then-emerging RCRA regulations, as they impacted the petroleum industry.

HONORARY AND PROFESSIONAL SOCIETIES:

Phi Kappa Phi, Sigma Gamma Epsilon, American Association of Petroleum Geologists, Geological Society of America, American Institute of Professional Geologists (certification in process).

FRED B. BLOOD

EDUCATION:

M.S., Biology (Aquatic Ecology), Virginia Commonwealth University, 1973

B.S., General Science (Biology and Chemistry), Virginia Polytechnic Institute, 1969.

EXPERIENCE:

Biologist, Radian Corporation, Austin, TX, 1981-Present.

Senior Consultant, Seagull Environmental Control, 1980-1981.

Technical Field Advisor, U.S. EPA Region V, Law Engineering Contract, 1979.

Aquatic Ecologist, Law Engineering Testing Co., 1976-1979.

Staff Biologist, Virginia Electric and Power Co., 1973-1976.

Visiting Scholar, Smithsonian Institute, 1973.

Teaching Assistant, Virginia Commonwealth University, 1971-1973.

Teacher, Henrico County (Virginia) Public Schools, 1969-1971.

FIELDS OF EXPERIENCE:

At Radian, Mr. Blood was responsible for managing the collection, identification, and interpretation of ecological data. His particular area of expertise involves aquatic ecology and environmental toxicology. The following project experience demonstrates his expertise.

Mr. Blood was task director on a U.S. EPA acid rain project. This project was established to collect and analyze water from 3500 lakes to determine the extent and susceptibility of U.S. lakes to acid deposition. This task involved various management functions including the preparation of audit samples to verify collection procedures and intralaboratory consistency and accuracy.

Mr. Blood has participated in U.S. Air Force IRP programs. The programs involve interviews, site visits, and environmental monitoring (generally ground water and soils). The purpose of the programs is to evaluate and document potential contamination from past practices of handling of hazardous waste on the bases. These studies have included five bases in Texas, Oklahoma, Utah, and Louisiana.

HONORARY AND PROFESSIONAL SOCIETIES:

Society of Environmental Toxicology and Chemistry, American Fisheries Society (Certified Fisheries Scientist), Ecological Society of America, Sport Fishing Institute.

APPENDIX B

Scope of Work

INSTALLATION RESTORATION PROGRAM
Phase II Field Evaluation
England AFB, Louisiana

I. Description of Work:

The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices, fuel spills and fire training activities at England AFB LA; to quantify the environmental contamination should contamination be found; and, to evaluate the magnitude, extent, direction of movement and potential environmental consequences of discovered contaminants.

Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished as required during drilling operations.

The presurvey report (mailed under separate cover) and Phase I IRP report (mailed under separate cover), incorporate background information and a description of the sites for this task. The contractor shall take the following steps to accomplish this field evaluation:

A. General.

1. Collect and analyze one sample from each of the existing wells (production or otherwise). A maximum of 4 wells shall be sampled. If the well(s) cannot be sampled due to well development, well characteristics (and or other reason), the contractor shall indicate the reason(s) in the report specified in Item VI below.

a. The US Air Force shall provide to the contractor well logs and other pertinent wells records and information to determine that samples collected are representative.

b. All water samples collected in A.1. above shall be analyzed for oil and grease using IR method (EPA Method 413.2) and purgeable hydrocarbons (EPA Method 602). Required detection limits for above analysis are as specifed in Atch 1.

2. All water samples collected shall be analyzed on site by the contractor for pH, temperature and specific conductance. Sampling, maximum holding time and preservation of soil and water samples shall strictly comply with the following references: Examination of Water and Wastewater, 15 Ed. (1980), pp 35-42; ASTM, Part 31, pp 72-82 (1976), Method D-3370; and Methods for Chemical Analysis of Water and Wastes, EPA Manual 600/4-79-020, pp xiii to xix (1979).

3. Determine the areal extent of each potentially contaminated location by reviewing available areal photos of the base, historical documentation and by field reconnaissance.

4. Professionally survey each site where samples are being collected, mark the site with a permanent marker (where practical) and record the location on a project map for the site.

5. Soil borings at each sampling site shall be hand-augered to a total depth of 10 feet or the first encounter of groundwater if less than 10 feet.

6. At each sampling site, one soil sample per 2.5 feet segment of boring shall be obtained with an additional sample obtained at the groundwater interface if encountered. One water sample at each of the monitoring sites listed in I.b. shall be taken at a groundwater interface if encountered.

B. Following the general protocol listed in paragraph I.A. above, the contractor shall collect soil and water samples at the following England AFB prioritized monitoring sites. Locations of borings shall be determined by the contractor in the field.

Monitoring Site	# Soil Borings	Maximum # of Soil Samples	Total # of Water Samples
Fire Training Site (FT-1)	10	50	1
POL Sludge Weathering Pit (D-15)	10	50	1
JP-4 Underground Line Leak (SP-3)	4	20	1
JP-4 Underground Line Leak (SP-4)	2	10	1
MOGAS Leak (SP-7)	4	20	1
JP-4 Underground Line Leak (SP-5)	1	5	1
CE Tank Spill (SP-6)	2	10	1

C. Sampling and Analysis.

1. All soil samples listed in paragraph I.B. shall be analyzed for oil and grease by EPA Method 413.1 (IR). All water samples listed in paragraph I.B. shall be analyzed for oil and grease (EPA Method 413.2) and purgeable hydrocarbons (EPA Method 602). Required detection limits for above analysis is specified in Atch 1.

D. Site Boring and Cleanup.

1. At each sampling site, the surface soil shall be collected with a trowel and the boring location prepared by removing grass, gravel or other surface materials. As the boring is advanced, cuttings shall be removed from the borehole and deposited on a temporary ground cover. The borehole shall be deepened to the next sampling interval and cleaned of loose cuttings prior to sampling. A clean soil probe, with extensions as needed, shall be used to collect the sample of soil. After each use, the probe shall be cleaned of dirt, washed in soap and water, rinsed with acetone, and re-rinsed with water.

2. After the completion of sampling activities, the borehole shall be backfilled with cuttings and bentonite, as needed, to within 2 feet of the original land surface. The remainder shall be sealed with neat cement grout. Excess cuttings shall be disposed of by England AFB personnel.

E. Data Review.

Results of sampling and analysis shall be tabulated and incorporated in the Infmoral Technical Information report (Sequence 3 Atch 1 and Sequence 2 Atch 3 as reflected in Item VI below) and forwarded to USAF OEHL CVT for review.

F. Report Preparation.

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL as specified in item VI below for Air Force review and comment. This report shall include soil and water sampling results, survey maps for each site, and laboratory quality assurance information.

2. At sites where contamination is identified, the report shall include pollutant concentrations, extent, direction and rates of migration of the contamination; and, an assessment of environmental consequences of hazards related to the contamination. These contamination data may be field generated and/or estimated based on mathematical models, statistical analyses, geologi ical and hydrogeological maps, engineering estimates or other procedures.

3. The report shall follow the USAF OEHL format (mailed under separate cover).

G. Quality Assurance.

The contractor shall adhere to all quality assurance/quality control procedures relating to laboratory coordination; on site coordination; engineering coordination; program management; project management; sampling procedures, chain of custody; field sampling operations; laboratory operations, calibration procedures, analytical procedures, data reduction, validation and reporting, internal quality control checks, performance and system audits, laboratory preventive maintenance, specific procedures used to assess data precision accuracy and completeness; and all sampling and analysis, as specified in Section II, para xxi of the contract.

II. Site Location and Dates:

England AFB LA
USAF Hospital England/SGPB
Dates to be established

III. Base Support:

A. Temporary office space and telephone.

B. Laboratory space for storage/preservation of soil samples.

C. Staging area for storage of drilling equipment.

D. Disposal of drill cuttings, if required.

IV. Government Furnished Property: None

V. Government Points of Contact:

1. Capt Gerald D. Swoboda
USAF OEHL/ECQ
Brooks AFB TX 78235
(512) 536-2891
AV 240-2891

2. MSgt Norman N. Howe
USAF Hospital England/SGPB
England AFB LA 71301
(318) 448-5357
AV 683-5357

3. Col Jerry Dougherty
HQ TAC/DEEV
Langley AFB VA 23665
(804) 764-2180
AV 432-2180

VI. In addition to sequence numbers 1, 5 and 10 listed in Atch 1 to the contract, which are applicable to all orders, the reference numbers below are applicable to this order. Also shown are data applicable to this order.

Sequence No.	Block 10	Block 11	Block 12	Block 13	Block 14
Atch 1					
4*	ONE/R	5.5 MAC	6 MAC	9 MAC	*
3	O/TIME	**	**		
Atch 3					
2	O/TIME	**	**		

* A minimum of two draft reports will be required. After incorporating Air Force comments concerning the first draft report, the contractor shall supply the USAF OEHL with a second draft report. The report shall be forwarded to the applicable regulatory agencies for their comments. Contractor shall supply the USAF OEHL with 20 copies of the draft report and 50 copies plus the original, camera ready copy of the final report.

** Upon completion of analyses

VII. The ceiling price of Items 0001 and 0002, as contemplated by the payments clause, is $

REQUIRED LIMITS OF DETECTION
FOR ANALYSES

Oils and Grease - 0.10 milligram/l (waters)
- 100 micrograms/gram (sediment and soil)

Volatile Aromatic Hydrocarbons - Detection limits as specified for compounds listed in EPA Method 602.

Atch 1

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APPENDIX C

Raw Field Data

APPENDIX C. DESCRIPTIONS OF SOIL SAMPLES, IRP PHASE II STAGE 1, ENGLAND AFB, LOUISIANA

Sample ID	Sample Interval	Sample Description
D-15 A-1	S*	Sandy silt, red-brown, damp, slightly plastic, some clay, ML.
D-15 A-2	18"-30"	Silty clay, red-brown, moist, plastic, minor fine sand, CL.
D-15 A-3	54"-66"	Silty clay, red-brown, saturated, plastic, CL.
D-15 B-1	S	Sandy silt, red-brown mottled with black, low plasticity, contains abundant rootlets, OL.
D-15 B-2	18"-30"	Silty sand, red-brown, moist to saturated, slight odor, SM.
D-15 B-3	54"-66"	Clayey silt, red-brown, saturated, strong odor, slightly plastic, OL.
D-15 C-1	S	Sandy silt, red-brown, damp, slightly plastic, ML.
D-15 C-2	18"-30"	Clayey silt, red-brown, moist, slightly plastic, strong odor, OL.
D-15 C-3	54"-66"	Silty clay, red-brown, saturated, plastic, CL.
D-15 D-1	S	Silty sand, red-brown, damp, contains abundant rootlets, SM.
D-15 D-2	18"-30"	Sandy silt, red-brown, moist, strong odor, some clay, ML.
D-15 D-3a	54"-66"	Silty clay, red-brown, saturated, moderate plasticity, strong odor, CL.
D-15 D-3b	54"-66"	" " " "

(Continued)

*S = surface.

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
D-15 E-1	S	Clayey silt, red-brown, slightly plastic, moist, some fine sand, OL.
D-15 E-2	18"-30"	Silty clay, red-brown mottled with black, moderate plasticity, moist, CL.
D-15 E-3	54"-66"	Clay, red-brown, saturated, highly plastic, minor silt, CH.
D-15 F-1	S	Silty sand, red-brown, damp, rootlets abundant, SM.
D-15 F-2	18"-30"	Clayey silt, dark red-brown, moist, some fine sand, rootlets abundant, OL.
D-15 F-3	54"-66"	Silty clay, red-brown, saturated, moderately plastic, CL.
D-15 G-1	S	Clayey silt, red-brown, damp, low plasticity, abundant rootlets, OL.
D-15 G-2	18"-30"	Silty clay, red-brown, moist, slightly plastic, strong odor, CL.
D-15 G-3	54"-66"	Clay, red brown, plastic, saturated, some silt, CH.
D-15 H-1	S	Silty fine sand, red-brown, damp, rootlets and black organic clasts present, SM.
D-15 H-2	18"-30"	Clayey silt, red-brown, slightly plastic, moist, ML.
D-15 H-3	54"-66"	Clayey silt, red-brown, slightly plastic, saturated, strong odor, ML.
D-15 I-1	S	Sandy silt, red-brown, damp, slightly plastic, some clay, ML.
D-15 I-2	18"-30"	Clayey silt, red-brown, moist, slightly plastic, ML.
D-15 I-3	54"-66"	Silty clay, red-brown mottled with black, saturated, plastic, strong odor, CL.

(Continued)

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
D-15 J-1	S	Silty fine sand, red-brown mottled with black, damp, strong odor, SM.
D-15 J-2	18"-30"	Silt, red brown, some clay, saturated, strong odor, ML.
D-15 K-1	S	Gravel and sand, dark brown, abundant rootlets, damp to moist, some fines, strong odor, GM.
D-15 K-2a	18"-30"	Clayey silt, red-brown, moist strong odor, some fine sand, ML.
D-15 K-2b	18"-30"	" " "
D-15 K-3	54"-66"	Clay, red-brown, plastic, saturated, some silt, strong odor, CH.
FT-1 A-1	S	Coarse sand and gravel, dark brown, damp, organic, some fines, SP.
FT-1 A-2	18"-30"	Silty fine sand, red-brown, moist, SM.
FT-1 A-3	54"-66"	Silty fine sand, red-brown, saturated, SM.
FT-1 B-1	S	Sand, poorly sorted, with some gravel and fines, dark brown, organic, damp, SP.
FT-1 B-2	18"-30"	Clayey silt, red-brown, saturated, slightly plastic, ML.
FT-1 C-1	S	Sandy silt, dark brown, organic, damp, slightly plastic, ML.
FT-1 C-2	18"-30"	Silt, red-brown, saturated, some fine sand, ML.

(Continued)

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
FT-1 D-1	S	Fine sandy silt, dark red-brown, damp, organic, minor gravel and clay, SM.
FT-1 D-2	18"-30"	Silt, red-brown, saturated, ML.
FT-1 D-3a	54"-66"	Clay, red-brown, plastic, saturated, CH.
FT-1 D-3b	54"-66"	" " " " "
FT-1 E-1	S	Coarse sand and gravel, dark brown, organic, damp, some fines, SP.
FT-1 E-2	18"-30"	Silty clay, red-brown, moist, medium plasticity, CL.
FT-1 F-1	S	Sand and gravel, very dark brown, organic, damp, some fines, SP.
FT-1 F-2a	18"-30"	Silt, red-brown, saturated, slightly plastic, ML.
FT-1 F-2b	18"-30"	" " " " "
FT-1 G-1	S	Sand and gravel, very dark brown, organic, damp, some fines, SP.
FT-1 G-2	18"-30"	Clayey silt, red-brown, slightly plastic, saturated, odor, ML.
FT-1 H-1	S	Sandy gravel, dark brown, organic, damp, odor, some fines, GP.
FT-1 H-2	18"-30"	Silty clay, red-brown, plastic, saturated, CL.
FT-1 I-1	S	Fine sandy silt, red-brown, damp, ML.
FT-1 I-2	18"-30"	Clayey silt, red-brown, saturated, slightly plastic, ML.

(Continued)

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
SP-3 A-1	S	Silty sand, red-brown, abundant rootlets, damp, somewhat plastic, SM.
SP-3 A-2	18"-30"	Silty clay, red-brown to gray brown, somewhat plastic, damp, strong odor, CL.
SP-3 A-3	54"-66"	Silty clay, red-brown, plastic, saturated, strong odor, visible contaminant slicks on sample, CL.
SP-3 B-1	S	Silty sand, red-brown, organic, damp, SM.
SP-3 B-2	18"-30"	Silty sand, red-brown, saturated, strong odor, SM.
SP-3 C-1	S	Silty sand, red-brown, organic, moist, SM.
SP-3 C-2	18"-30"	Clayey silt, red-brown, saturated, slightly plastic, some fine sand, ML.
SP-3 D-1	S	Silty clay, red-brown, damp, moderately plastic, some fine sand, CL.
SP-3 D-2	18"-30"	Silty clay, red-brown, saturated, plastic, visible contaminated slicks on sample.
SP-4 A-1	S	Silty fine sand, dark brown, organic, damp, SM.
SP-4 A-2	18"-30"	Silty clay, red-brown, saturated, plastic, CL.
SP-4 B-1	S	Clayey silt, dark brown, damp, slightly plastic, organic, ML.
SP-4 B-2	18"-30"	Clay, reddish brown, saturated, plastic, some silt, CL.
SP-5 A-1	S	Silty clay, reddish brown, plastic, organic, damp, CL.
SP-5 A-2	18"-30"	Clay, red, plastic, moist to saturated, some silt, CL.

(Continued)

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
SP-5 A-3	54"-66"	Silty clay, red, saturated, plastic, CL.
SP-6 A-1	S	Sandy silt, black, abundant organics, strong odor, moist, poorly sorted, ML.
SP-6 A-2	18"-30"	Fine sandy silt, red-brown, damp, ML.
SP-6 A-3	45"-57"	Silty clay, red-brown, moist, plastic, CL.
SP-6 A-4	84"-96"	Silty clay, red-brown, moist, plastic, CL.
SP-6 A-5	114"-126"	Silty clay, red-brown, saturated, plastic, CL.
SP-6 B-1	S	Sandy silt, red-brown with black staining, organics, odor, moist, ML.
SP-6 B-2	18"-30"	Clayey silt, red-brown, moist, ML.
SP-6 B-3	54"-66"	Clayey silt, red-brown, saturated, slightly plastic, ML.
SP-7 A-1	S	Clayey sand, medium-grained, red-brown, damp, SC.
SP-7 A-2	18"-30"	Sandy silt, red-brown, moist, strong odor, includes pieces of asphalt, ML.
SP-7 A-3	54"-66"	Gravelly clay, red-brown, moist to saturated in zones, strong odor, CL.
SP-7 A-4	84"-96"	Sandy clay, red-brown, moist to saturated, some silt, black wood fragments, CL.
SP-7 A-5	114"-126"	Silty sand, red-brown, saturated with some asphalt and organic debris, strong odor, SM.

(Continued)

APPENDIX C. (Continued)

Sample ID	Sample Interval	Sample Description
SP-7 B-1	S	Silty sand, red-brown, damp, SM.
SP-7 B-2	18"-30"	Coarse sand, silt matrix, red-brown, damp, strong odor, SM.
SP-7 B-3	54"-66"	Coarse sand, silt and clay matrix, red-brown, saturated with iridescent viscous fluid, SM.
SP-7 B-4	84"-96"	Sandy clay, red-brown, saturated, plastic, strong odor, CL.
SP-7 C-1	S	Silty sand, red-brown, damp, SM.
SP-7 C-2	18"-30"	Sandy silt, red-brown with black asphalt clasts, moist, slight odor, ML.
SP-7 C-3	54"-66"	Gravelly coarse sand, yellow to brown, saturated, SP.
SP-7 D-1	S	Silty sand, red-brown, damp, rootlets, SM.
SP-7 D-2	18"-30"	Coarse sand, yellow-brown, silty matrix, damp, strong odor, SM.
SP-7 D-3	54"-66"	Coarse sand, red-brown, poorly sorted with gravel and silt matrix, moist, SM.
SP-7 D-4	76"-88"	Coarse sand, yellow, with red-brown silt and clay matrix, saturated, strong odor, SM.

RADIAN
CORPORATION

APPENDIX D

Chain-of-Custody Forms

212-027-10-05

RADIAN
CORPORATION

(96 samples total incl. dupl. - in 6 ice chests)

CHAIN OF CUSTODY RECORD

Field Sample No. SP-3,-4,-5,-6,-7; D-15; FT-1

Company Sampled/Address England AFB, Alexandria, LA

Sample Point Description JP-4 and diesel fuel spill and leak areas; POL disposal area; Fire training area

Stream Characteristics: NA - soils

Temperature ______ Flow — pH —

Visual Observations/Comments Some samples have visible oily substances on surface.

Collector's Name Debra L. Richman Date/Time Sampled 2/29 - 3/3/84

Amount of Sample Collected 12" x 3/4"d core

Sample Description Soils

Store at: ☐ Ambient ☒ 5°C ☐ -10°C ☐ Other ______

☐ Caution - No more sample available ☐ Return unused portion of sample ☐ Discard unused portions

Other Instructions - Special Handling - Hazards Please notify me to check samples before they are analyzed if analysis is destructive and entire sample will be used, otherwise, hold unused portion 'til I am notified.

☒ Hazardous sample (see below) ☐ Non-hazardous sample

☐ Toxic	☒ Skin irritant	☐ Flammable (FP< 40°C)
☐ Pyrophoric	☐ Lachrymator	☐ Shock sensitive
☐ Acidic	☐ Biological	☐ Carcinogenic - suspect
☐ Caustic	☐ Peroxide	☐ Radioactive
☐ Other ______		

Sample Allocation/Chain of Possession:

Organization Name Radian Analytical Services

Received By [illegible signature] Date Received 3-6-84 Time 10:30

Transported By Fed Ex Lab Sample No. 8403030, 8403031, 8403032

Comments ______

Inclusive Dates of Possession ______

Organization Name ______

Received By ______ Date Received ______ Time ______

Transported By ______ Lab Sample No. ______

Comments ______

Inclusive Dates of Possession ______

Organization Name ______

Received By ______ Date Received ______ Time ______

Transported By ______ Lab Sample No. ______

Comments ______

Inclusive Dates of Possession ______

RADIAN
CORPORATION

CHAIN OF CUSTODY RECORD

R- 1146, 1147, 1148,

Field Sample No. SP-3A, 4A, 5A, 6A, 7B; DP-15 G; FT-1 D

Company Sampled/Address England AFB, Alexandria, LA

Sample Point Description USGS Monitor wells ( ); JP-4 spills/leaks; POL disposal area; fire training area; Fuel oil spills

Stream Characteristics:

Temperature 12°- 14°C Flow ______ pH 5-6

Visual Observations/Comments oily film observed on some samples

Collector's Name Debra L. Richmann Date/Time Sampled 3/3-4/84

Amount of Sample Collected 1 qt + 2- 40 ml vials, each

Sample Description Ground water

Store at: ☐ Ambient ☑ 5°C ☐ −10°C ☐ Other ______

☑ Caution - No more sample available ☐ Return unused portion of sample ☐ Discard unused portions

Other Instructions - Special Handling - Hazards ______

☑ Hazardous sample (see below) ☐ Non-hazardous sample

☐ Toxic	☑ Skin irritant	☐ Flammable (FP< 40°C)
☐ Pyrophoric	☐ Lachrymator	☐ Shock sensitive
☐ Acidic	☐ Biological	☐ Carcinogenic - suspect
☐ Caustic	☐ Peroxide	☐ Radioactive
☐ Other		

Sample Allocation/Chain of Possession:

Organization Name Radian Analytical Services

Received By [illegible] Date Received 3-6-84 Time 10:30

Transported By Fed Ex Lab Sample No. 8403028

Comments ______

Inclusive Dates of Possession ______

Organization Name ______

Received By ______ Date Received ______ Time ______

Transported By ______ Lab Sample No. ______

Comments ______

Inclusive Dates of Possession ______

Organization Name ______

Received By ______ Date Received ______ Time ______

Transported By ______ Lab Sample No. ______

Comments ______

Inclusive Dates of Possession ______

APPENDIX E

Surveyor's Plats

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

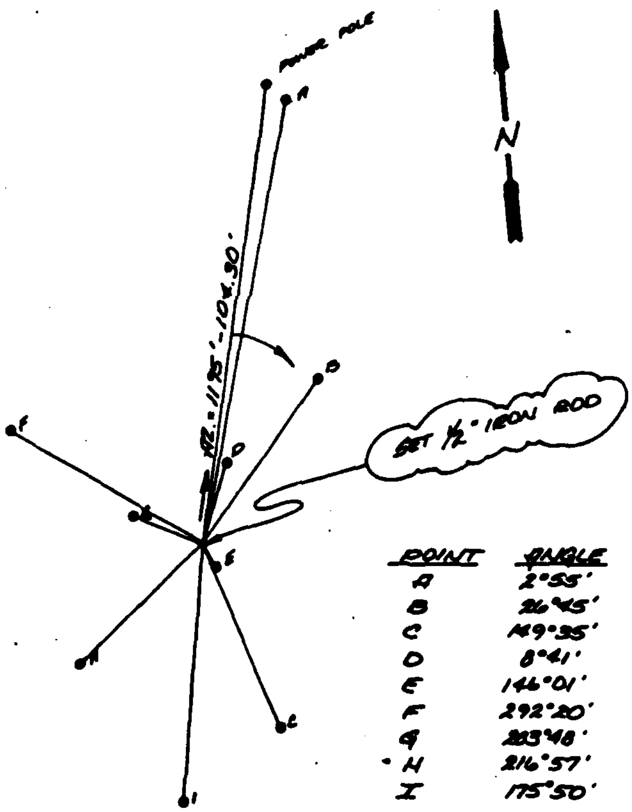
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE FT.-1



POINT	ANGLE	DISTANCE
A	2°55'	102.02'
B	26°45'	45.10'
C	149°35'	45.62'
D	8°41'	18.86'
E	146°01'	7.26'
F	292°20'	49.96'
G	283°48'	16.14'
H	216°57'	39.30'
I	175°50'	59.16'

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 18638
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 4464
REGISTERED
LAND SURVEYOR

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

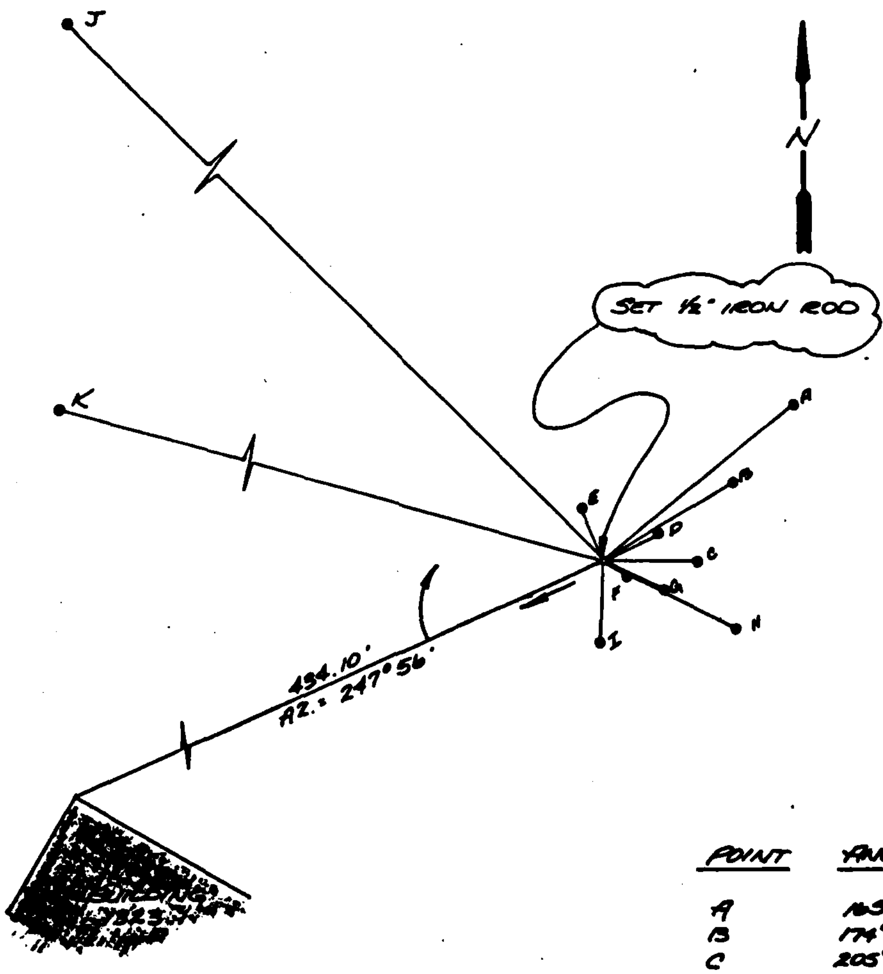
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

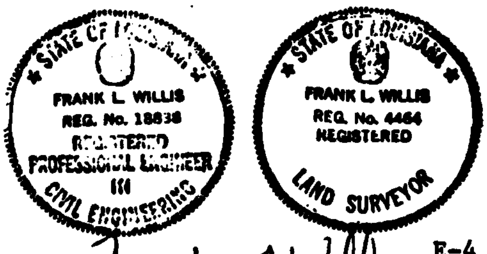
FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE D-15



POINT	ANGLE	DISTANCE
A	165°22'	54.70'
B	174°23'	33.78'
C	205°15'	20.58'
D	177°56'	14.18'
E	92°31'	12.92'
F	232°07'	6.02'
G	230°28'	15.82'
H	231°37'	23.12'
I	297°27'	18.35'
J	69°59'	352.76
K	40°05'	416.68'



Frank L. Willis

C E R T I F I C A T E   O F   S U R V E Y

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

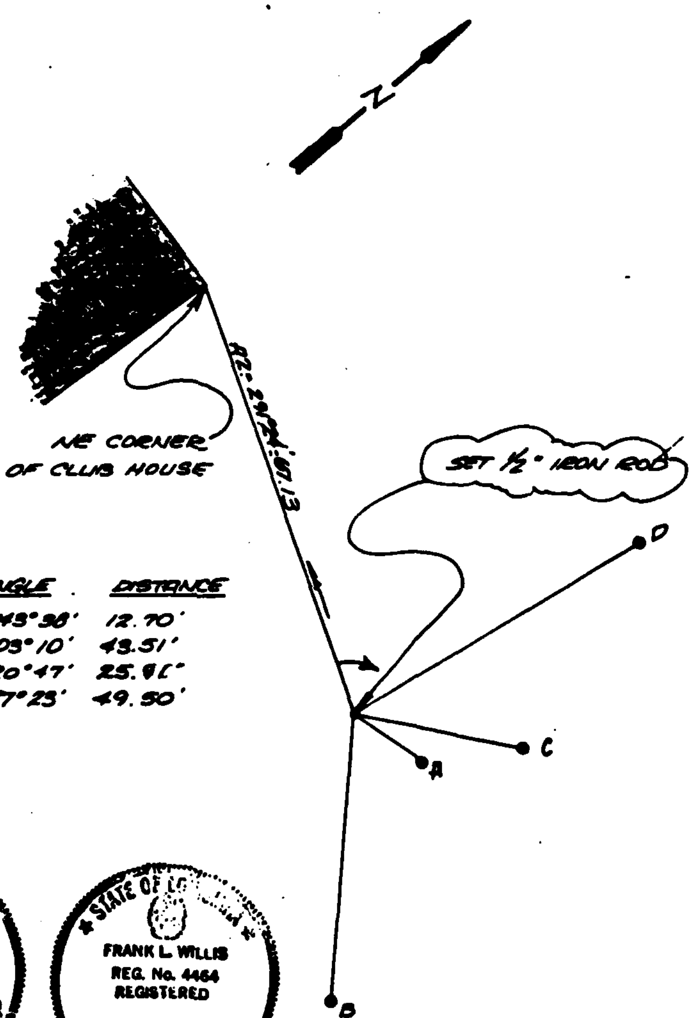
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE SP-3



	ANGLE	DISTANCE
POINT A	143°38'	12.70'
POINT B	203°10'	43.51'
POINT C	120°47'	25.96'
POINT D	77°25'	49.50'

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 18838
REGISTERED
PROFESSIONAL ENGINEER
CIVIL ENGINEERING

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 4464
REGISTERED
LAND SURVEYOR

Frank L Willis

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

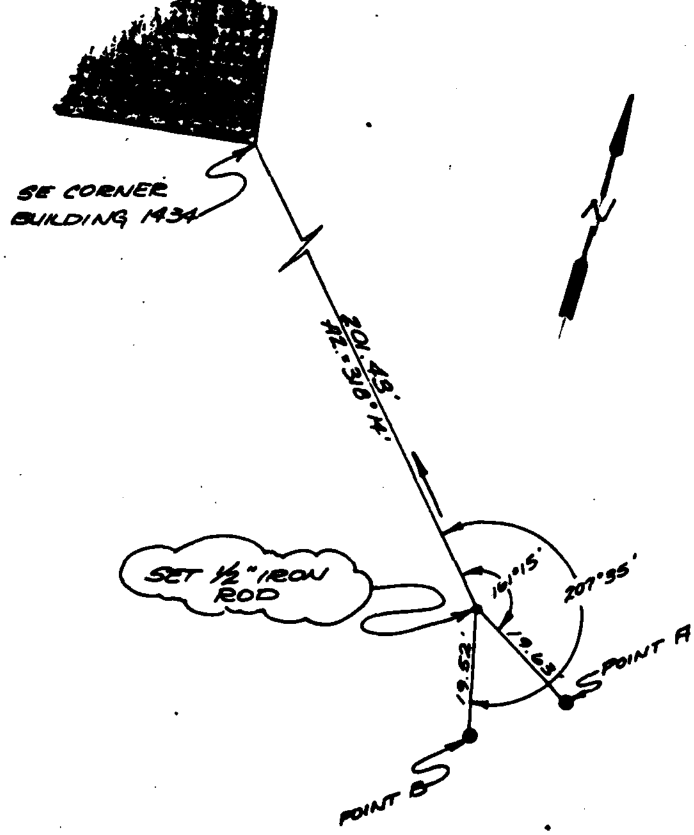
SOIL BORING LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE SP-4



STATE OF LOUISIANA
FRANK L. WILLIS
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IN
CIVIL ENGINEERING

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 4464
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LAND SURVEYOR

Frank L Willis

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

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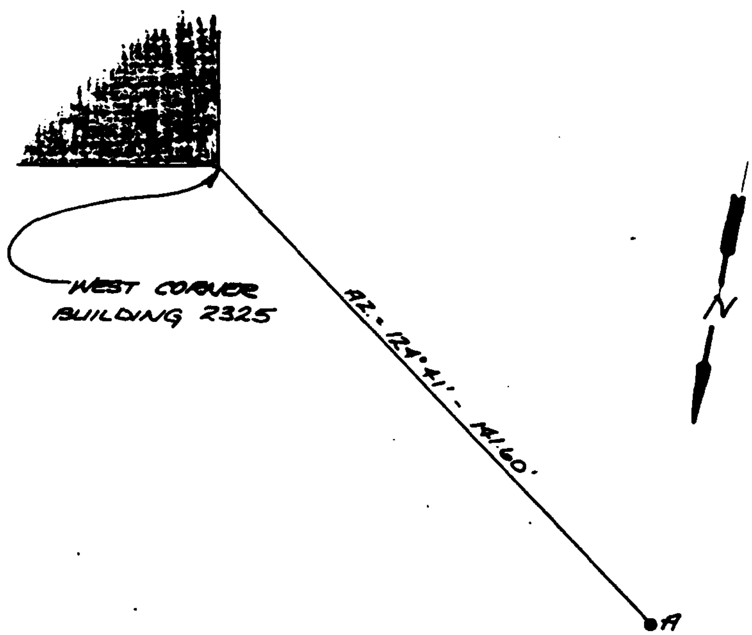
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE SP.5



STATE OF LOUISIANA
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CIVIL ENGINEERING

STATE OF LOUISIANA
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REGISTERED
LAND SURVEYOR

Frank L. Willis

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

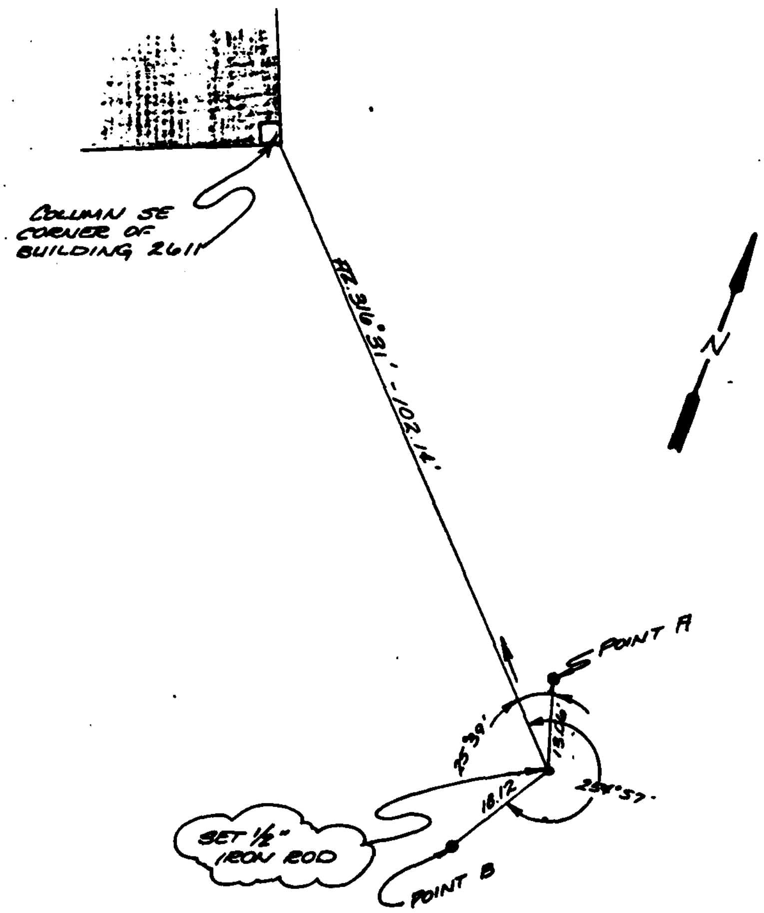
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE SP-6



STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 18838
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 4464
REGISTERED
LAND SURVEYOR

Frank L. Willis

CERTIFICATE OF SURVEY

Alexandria, Louisiana 4-6 19 84

I HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE SURVEY MADE OF THE FOLLOWING DESCRIBED TRACT OF LAND:

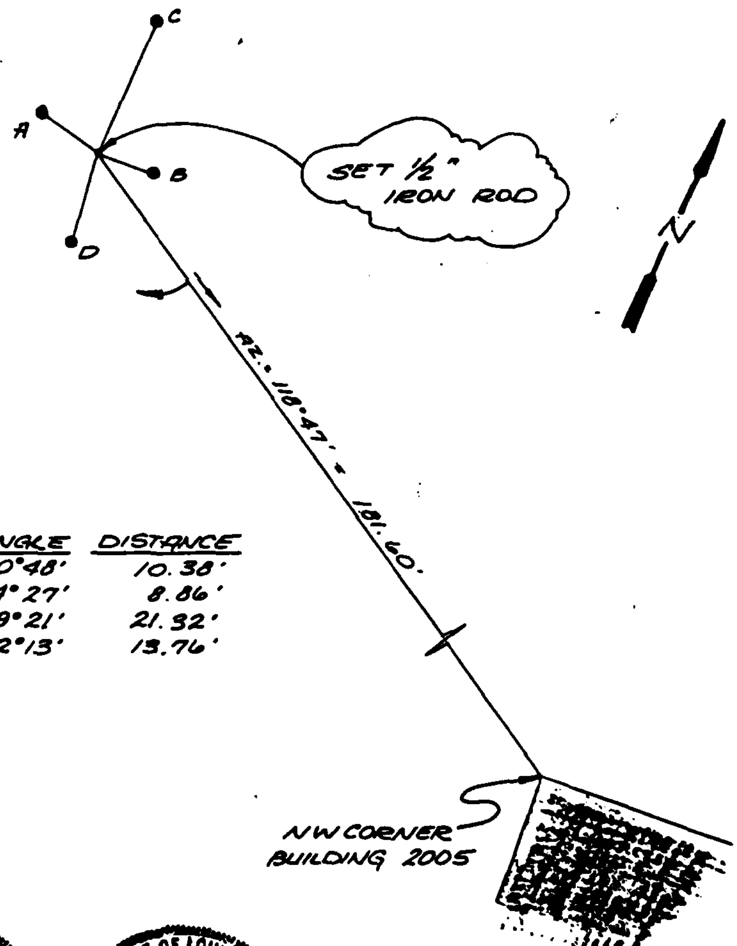
SOIL BORING
LOCATIONS

ENGLAND AIR FORCE BASE

FRANK L. WILLIS & ASSOCIATES
CONSULTING ENGINEERS &
LAND SURVEYORS

REG. NO. 4464

SITE SP-7



POINT	ANGLE	DISTANCE
A	160°48'	10.38'
B	324°27'	8.86'
C	239°21'	21.32'
D	52°13'	13.76'

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 18838
REGISTERED
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

STATE OF LOUISIANA
FRANK L. WILLIS
REG. No. 4464
REGISTERED
LAND SURVEYOR

Frank L. Willis

APPENDIX F

Analytical Data

CORPORATION

Analytical Serv REPORT LAB # 84-03-031

RECEIVED: 03/06/84 03/23/84 12:07:28

REPORT TO Radian
Bl. 4
Austin

ATTEN Debra Richmann

CLIENT ENGLAND AFB SAMPLES 22
COMPANY England AFB
FACILITY

PREPARED BY Radian Analytical Services
8501 MoPac Blvd.
P.O. Box 9948
Austin, Texas 78766

ATTEN
PHONE (512) 454-4797

CERTIFIED BY

CONTACT CONOVER

WORK ID soils, FT-1 series
TAKEN DLR
TRANS Fed Ex
TYPE
P.O. # 212-027-10-05
INVOICE under separate cover

F-3

SAMPLE IDENTIFICATION

01 FT-1 A-1
02 FT-1 A-2
03 FT-1 A-3
04 FT-1 B-1
05 FT-1 B-2
06 FT-1 C-1
07 FT-1 C-2
08 FT-1 D-1
09 FT-1 D-2
10 FT-1 D-3a
11 FT-1 D-3b
12 FT-1 E-1
13 FT-1 E-2
14 FT-1 F-1
15 FT-1 F-2a
16 FT-1 F-2b
17 FT-1 G-1
18 FT-1 G-2
19 FT-1 H-1
20 FT-1 H-2
21 FT-1 I-1

Analytical Serv TEST CODES and NAMES used on this report

ONG IR Oil and Grease, Infrared

SAMPLE IDENTIFICATION

22 FT-1 I-2

RECEIVED: 03/06/84 RESULTS BY TEST

TEST CODE default units	Sample 01 (entered units)	Sample 02 (entered units)	Sample 03 (entered units)	Sample 04 (entered units)	Sample 05 (entered units)
ONG_IR mg/L	1.2 %	2900 ug/g	2800 ug/g	1.5 %	1900 ug/g

TEST CODE default units	Sample 06 (entered units)	Sample 07 (entered units)	Sample 08 (entered units)	Sample 09 (entered units)	Sample 10 (entered units)
ONG_IR mg/L	2100 ug/g	3900 ug/g	8200 ug/g	2600 ug/g	3040 ug/g

F-5

TEST CODE default units	Sample 11 (entered units)	Sample 12 (entered units)	Sample 13 (entered units)	Sample 14 (entered units)	Sample 15 (entered units)
ONG_IR mg/L	<10 ug/g	1.4 %	4200 ug/g	5900 ug/g	2900 ug/g

TEST CODE default units	Sample 16 (entered units)	Sample 17 (entered units)	Sample 18 (entered units)	Sample 19 (entered units)	Sample 20 (entered units)
ONG_IR mg/L	<10 ug/g	1800 ug/g	5400 ug/g	9800 ug/g	3800 ug/g

TEST CODE default units	Sample 21 (entered units)	Sample 22 (entered units)
ONG_IR mg/L	7700 ug/g	7300 ug/g

PAGE 1 | Analytical Serv REPORT | LAB # 84-03-030
RECEIVED: 03/06/84 | 03/23/84 12:04:50

REPORT TO: Radian
Bl. 4
Austin

ATTEN: Debra Richmann

CLIENT: ENGLAND AFB   SAMPLES: 34
COMPANY: England AFB
FACILITY:

PREPARED BY: Radian Analytical Services
8501 MoPac Blvd.
P.O. Box 9948
Austin, Texas 78766

ATTEN:
PHONE: (512) 454-4797

CERTIFIED BY

CONTACT: CONOVER

WORK ID: soils, D-15 series
TAKEN: DLR
TRANS: Fed Ex
TYPE:
P.O. #: 212-027-10-05
INVOICE: under separate cover

F-6

SAMPLE IDENTIFICATION

01 D-15 A-1
02 D-15 A-2
03 D-15 A-3
04 D-15 B-1
05 D-15 B-2
06 D-15 B-3
07 D-15 C-1
08 D-15 C-2
09 D-15 C-3
10 D-15 D-1
11 D-15 D-2
12 D-15 D-3a
13 D-15 D-3b
14 D-15 E-1
15 D-15 E-2
16 D-15 E-3
17 D-15 F-1
18 D-15 F-2
19 D-15 F-3
20 D-15 G-1
21 D-15 G-2

Analytical Serv TEST CODES and NAMES used on this report

ONG IR Oil and Grease, Infrared

RECEIVED: 03/06/84 03/23/84 12:04:50

SAMPLE IDENTIFICATION

22 D-15 G-3
23 D-15 H-1
24 D-15 H-2
25 D-15 H-3
26 D-15 I-1
27 D-15 I-2
28 D-15 I-3
29 D-15 J-1
30 D-15 J-2
31 D-15 K-1
32 D-15 K-2a
33 D-15 K-2b
34 D-15 K-3

CORPORATION

RECEIVED: 03/06/84

Analytical Serv REPORT
RESULTS BY TEST

LAB # 84-03-030

TEST CODE default units	Sample 01 (entered units)	Sample 02 (entered units)	Sample 03 (entered units)	Sample 04 (entered units)	Sample 05 (entered units)
ONG_IR mg/L	5200 ug/g	3400 ug/g	1.5 %	4.1 %	4800 ug/g

TEST CODE default units	Sample 06 (entered units)	Sample 07 (entered units)	Sample 08 (entered units)	Sample 09 (entered units)	Sample 10 (entered units)
ONG_IR mg/L	1.8 %	3.6 %	4.0 %	1.6 %	2800 ug/g

TEST CODE default units	Sample 11 (entered units)	Sample 12 (entered units)	Sample 13 (entered units)	Sample 14 (entered units)	Sample 15 (entered units)
ONG_IR mg/L	8500 ug/g	<10 ug/g	5300 ug/g	3800 ug/g	2900 ug/g

TEST CODE default units	Sample 16 (entered units)	Sample 17 (entered units)	Sample 18 (entered units)	Sample 19 (entered units)	Sample 20 (entered units)
ONG_IR mg/L	5300 ug/g	8800 ug/g	4800 ug/g	7200 ug/g	2000 ug/g

TEST CODE default units	Sample 21 (entered units)	Sample 22 (entered units)	Sample 23 (entered units)	Sample 24 (entered units)	Sample 25 (entered units)
ONG_IR mg/L	910 ug/g	920 ug/g	<10 ug/g	<10 ug/g	3400 ug/g

RECEIVED: 03/06/84

Analytical Serv REPORT

RESULTS BY TEST

LAB # 84-03-030

TEST CODE default units	Sample 26 (entered units)	Sample 27 (entered units)	Sample 28 (entered units)	Sample 29 (entered units)	Sample 30 (entered units)
ONG_IR mg/L	1800 ug/g	<10 ug/g	<10 ug/g	880 ug/g	1200 ug/g

TEST CODE default units	Sample 31 (entered units)	Sample 32 (entered units)	Sample 33 (entered units)	Sample 34 (entered units)
ONG_IR mg/L	5500 ug/g	5800 ug/g	3800 ug/g	5100 ug/g

PAGE 1 Analytical Serv REPORT LAB # 84-03-032
RECEIVED: 03/06/84 03/23/84 12:09:30

REPORT TO Radian
Bl. 4
Austin

ATTEN Debra Richmann

CLIENT ENGLAND AFB SAMPLES 40
COMPANY England AFB
FACILITY

PREPARED BY Radian Analytical Services
8501 MoPac Blvd.
P.O. Box 9948
Austin, Texas 78766

ATTEN
PHONE (512) 454-4797

CERTIFIED BY

CONTACT CONOVER

WORK ID soils, SP series
TAKEN DLR
TRANS Fed Ex
TYPE
P.O. # 212-027-10-05
INVOICE under separate cover

F-10

SAMPLE IDENTIFICATION

01 SP-3 A-1
02 SP-3 A-2
03 SP-3 A-3
04 SP-3 B-1
05 SP-3 B-2
06 SP-3 C-1
07 SP-3 C-2
08 SP-3 D-1
09 SP-3 D-2
10 SP-4 A-1
11 SP-4 A-2
12 SP-4 B-1
13 SP-4 B-2
14 SP-5 A-1
15 SP-5 A-2
16 SP-5 A-3
17 SP-6 A-1
18 SP-6 A-2
19 SP-6 A-3 (45"-57")
20 SP-6 A-4 (7'-8')
21 SP-6 A-5

Analytical Serv TEST CODES and NAMES used on this report

ONG IR Oil and Grease, Infrared

Analytical Serv REPORT
LAB # 84-03-032
RECEIVED: 03/06/84
03/23/84 12:09:30

SAMPLE IDENTIFICATION

22 SP-6 B-1
23 SP-6 B-2
24 SP-6 B-3
25 SP-7 A-1
26 SP-7 A-2
27 SP-7 A-3
28 SP-7 A-4
29 SP-7 A-5
30 SP-7 B-1
31 SP-7 B-2
32 SP-7 B-3
33 SP-7 B-4
34 SP-7 C-1
35 SP-7 C-2
36 SP-7 C-3
37 SP-7 D-1
38 SP-7 D-2
39 SP-7 D-3
40 SP-7 D-4

Analytical Serv REPORT LAB # 84-03-032
RECEIVED: 03/06/84
RESULTS BY TEST

TEST CODE default units	Sample 01 (entered units)	Sample 02 (entered units)	Sample 03 (entered units)	Sample 04 (entered units)	Sample 05 (entered units)
ONG_IR mg/L	9100 ug/g	5500 ug/g	5700 ug/g	950 ug/g	2400 ug/g

TEST CODE default units	Sample 06 (entered units)	Sample 07 (entered units)	Sample 08 (entered units)	Sample 09 (entered units)	Sample 10 (entered units)
ONG_IR mg/L	1.05 %	1900 ug/g	5800 ug/g	4400 ug/g	<10 ug/g

TEST CODE default units	Sample 11 (entered units)	Sample 12 (entered units)	Sample 13 (entered units)	Sample 14 (entered units)	Sample 15 (entered units)
ONG_IR mg/L	6800 ug/g	<10 ug/g	<10 ug/g	<10 ug/g	560 ug/g

TEST CODE default units	Sample 16 (entered units)	Sample 17 (entered units)	Sample 18 (entered units)	Sample 19 (entered units)	Sample 20 (entered units)
ONG_IR mg/L	<10 ug/g	5.4 %	<10 ug/g	820 ug/g	6400 ug/g

TEST CODE default units	Sample 21 (entered units)	Sample 22 (entered units)	Sample 23 (entered units)	Sample 24 (entered units)	Sample 25 (entered units)
ONG_IR mg/L	7900 ug/g	1.5 %	8000 ug/g	1.5 %	1.5 %

RECEIVED: 03/06/84

CORPORATION

Analytical Serv REPORT LAB # 84-03-032

RESULTS BY TEST

TEST CODE default units	Sample 26 (entered units)	Sample 27 (entered units)	Sample 28 (entered units)	Sample 29 (entered units)	Sample 30 (entered units)
ONG_IR mg/L	8900 ug/g	7900 ug/g	1500 ug/g	4600 ug/g	2700 ug/g

TEST CODE default units	Sample 31 (entered units)	Sample 32 (entered units)	Sample 33 (entered units)	Sample 34 (entered units)	Sample 35 (entered units)
ONG_IR mg/L	1400 ug/g	<10 ug/g	3.6 %	5200 ug/g	4000 ug/g

TEST CODE default units	Sample 36 (entered units)	Sample 37 (entered units)	Sample 38 (entered units)	Sample 39 (entered units)	Sample 40 (entered units)
ONG_IR mg/L	2600 ug/g	1.7 %	4940 ug/g	7.9 %	1900 ug/g

CORPORATION

PAGE 1 — Analytical Serv REPORT — LAB # 84-03-020

RECEIVED: 03/08/84 — 03/16/84 10:57:31

REPORT TO: [illegible]
Austin

ATTEN: [illegible] Richmann

CLIENT: England AFB — SAMPLES 10
COMPANY: England AFB
FACILITY:

PREPARED BY: Radian Analytical Services
8501 MoPac Blvd
P.O. Box 9948
Austin, Texas 787[illegible]

ATTEN:
PHONE: (512) 454-4797

CERTIFIED BY

CONTACT CONOVER

*Note: detection limit is 1 ug/L unless otherwise stated

WORK ID: groundwater
TAKEN: [illegible]
TRANS: Fed Ex
TYPE:
P.O. #: 21-027-10-05
INVOICE: under separate cover

SAMPLE IDENTIFICATION

01 R-1146
02 R-1147
03 R-1148
04 SP-3A
05 SP-[illegible]
06 SP-5A
07 SP-[illegible]
08 SP-[illegible]
09 D-[illegible]
10 FI [illegible]

Analytical Serv TEST CODES and NAMES used on this report

GC 602 EPA Method 602/GC
ONG IR Oil and Grease, Infrared

CORPORATION

PAGE 2 Analytical Serv REPORT LAB # 84-03-028

RECEIVED [illegible] RESULTS BY TEST

TEST CODE default units	Sample 01 (entered units)	Sample 02 (entered units)	Sample 03 (entered units)	Sample 04 (entered units)	Sample 05 (entered units)
UNG_IR mg/L	4	5	4	7	5

TEST CODE default units	Sample 06 (entered units)	Sample 07 (entered units)	Sample 08 (entered units)	Sample 09 (entered units)	Sample 10 (entered units)
UNG_IR mg/L	6	7	6	20	6

CORPORATION

PAGE 3 Analytical Serv REPORT LAB # 84-05-038
RECEIVED: 05/08/84 Results by Sample

SAMPLE ID 2-1148 FRACTION 01B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE [illegible] DATE INJECTED 05/14/84 ANALYST MCL VERIFIED BY [illegible]
CONC. FACTOR [illegible] INSTRUMENT [illegible] COMPOUNDS DETECTED [illegible]

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	NDa		1,3-Dichlorobenzene	ND
[illegible]	Toluene	2		1,2 Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

Notes and definitions for this report:
SCAN = scan number of retention time [illegible]
All results reported in ug/L unless otherwise specified
ND = not detected at the detection limit method [illegible] (Federal Register [illegible])

CORPORATION

PAGE 4
RECEIVED: 03/06/84

Analytical Serv REPORT
Results by Sample

LAB # 84-03-028

SAMPLE ID R-1147 FRACTION 02B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/14/84 ANALYST MCL VERIFIED BY
CONC FACTOR INSTRUMENT J COMPOUNDS DETECTED 1

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	ND		1,3-Dichlorobenzene	ND
1	Toluene	3		1,2-Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = scan number or retention time on chromatogram
All results reported in ug/l unless otherwise specified
ND = not detected at [illegible] detection limit method 602 (Federal Register, 12/3/79)

CORPORATION

PAGE 5 Analytical Serv REPORT LAB # 84-03-028
RECEIVED: 03/08/84 Results by Sample

SAMPLE ID R-1148 FRACTION 03B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/14/84 ANALYST MCL VERIFIED BY
CONC. FACTOR INSTRUMENT d COMPOUNDS DETECTED 0

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	ND		1,3-Dichlorobenzene	ND
	Toluene	ND		1,2-Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = scan number or retention time on chromatogram
All results reported in ug/L unless otherwise specified
ND = not detected at EPA detection limit method 602 (Federal Register 12/3/79)

CORPORATION

PAGE 6 | Analytical Serv REPORT | LAB # 84-03-028
RECEIVED: 03/06/84 | Results by Sample

SAMPLE ID SP-3A FRACTION 04B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE 0 DATE INJECTED 03/14/84 ANALYST RGS VERIFIED BY JSG
CONC. FACTOR INSTRUMENT d COMPOUNDS DETECTED 6

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
1	Benzene	2350		1,3-Dichlorobenzene	<50
	Toluene	<50		1,2-Dichlorobenzene	<50
	Ethyl Benzene	<50		1,4-Dichlorobenzene	<50

NOTES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number or retention time on chromatogram.
All results reported in ug/L unless otherwise specified
ND = not detected at EPA detection limit method 602, (Federal Register, 12/3/79).

CORPORATION

PAGE 7 Analytical Serv REPORT LAB # 84-03-028
RECEIVED: 03/06/84 Results by Sample

SAMPLE ID SP-4A FRACTION 05B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/14/84 ANALYST RCS VERIFIED BY JSG
CONC. FACTOR INSTRUMENT J COMPOUNDS DETECTED 0

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	ND		1,3-Dichlorobenzene	ND
	Toluene	ND		1,2-Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = scan number or retention time on chromatogram
All results reported in ug/l unless otherwise specified
ND = not detected at EPA detection limit method 602, Federal Register 12/3/79

CORPORATION

Analytical Serv REPORT LAB # 84-03-028

RECEIVED: 03/06/84 Results by Sample

SAMPLE ID SF-5A FRACTION 06B TEST CODE GC 602 NAME EPA Method 602/GC

Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/14/84 ANALYST RGS VERIFIED BY JSG

CONC FACTOR INSTRUMENT 4 COMPOUNDS DETECTED 0

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	ND		1,3-Dichlorobenzene	ND
	Toluene	ND		1,2-Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number or retention time on chromatogram

All results reported in ug/L unless otherwise specified

ND = not detected at EPA detection limit method 602 (Federal Register, 12/3/79)

CORPORATION

LAB # 84-03-028

Analytical Serv REPORT
Results by Sample

PAGE 9
RECEIVED: 03/06/84

FRACTION 07B TEST CODE GC 602 NAME EPA Method 602/GC
Category

SAMPLE ID SP-6A
Date & Time Collected not specified

ANALYST RGS
INSTRUMENT d

VERIFIED BY JBG
COMPOUNDS DETECTED 1

DATE INJECTED 03/15/84

DATA FILE E
CONC. FACTOR

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	benzene	ND		1,3-Dichlorobenzene	ND
1	Toluene	26		1,2-Dichlorobenzene	ND
	Ethyl benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT [illegible]
SCAN = scan number of [illegible] on chromatogram
All results reported in [illegible] unless otherwise specified
ND = not detected at EPA detection limit method 602 [illegible] 12/03/79

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CORPORATION

PAGE 10 Analytical Serv REPORT LAB # 84-03-028

RECEIVED: 03/06/84 Results by Sample

SAMPLE ID SP-7B FRACTION 08B TEST CODE GC 602 NAME EPA Method 602/GC

Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/15/84 ANALYST BGS VERIFIED BY

CONC. FACTOR INSTRUMENT d COMPOUNDS DETECTED 6

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
1	Benzene	4200		1,3-Dichlorobenzene	<100
2	Toluene	8600		1,2-Dichlorobenzene	<100
	Ethyl Benzene	3900		1,4-Dichlorobenzene	<100

NOTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number or retention time on chromatogram

All results reported in ug/L unless otherwise specified

ND = not detected at EPA detection limit method 602 (Federal Register, 12/3/79).

CORPORATION

PAGE 1[illegible] Analytical Serv REPORT LAB # 84-03-028
RECEIVED: 03/06/84 Results by Sample

SAMPLE ID D -15C FRACTION 09B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/15/84 ANALYST RGS VERIFIED BY [illegible]
CONC. FACTOR INSTRUMENT d COMPOUNDS DETECTED 6

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
1	Benzene	950		1,3-Dichlorobenzene	[illegible]
	Toluene	45		1,2-Dichlorobenzene	[illegible]
[illegible]	Ethyl Benzene	260		1,4-Dichlorobenzene	[illegible]

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = Scan number or retention time on chromatogram
All results reported in ug/L unless otherwise specified
ND = not detected at EPA detection limit method 602, (Federal Register, 12/3/79)

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CORPORATION

PAGE 12
RECEIVED: 03/06/84

Analytical Serv REPORT
Results by Sample

LAB # 84-03-025

SAMPLE ID LI-10

FRACTION 10B TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE B
CONC FACTOR

DATE INJECTED 03/15/84

ANALYST RGS
INSTRUMENT J

VERIFIED BY JGO
COMPOUNDS DETECTED 2

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
1	Benzene	125		1,3-Dichlorobenzene	ND
	Toluene	ND		1,2-Dichlorobenzene	ND
5	Ethyl Benzene	11		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = scan number or retention time on chromatogram
All results reported in ug/l unless otherwise specified
ND = not detected at EPA detection limit method 602 (Federal Register 12/3/79)

CORPORATION

RECEIVED: 03/06/84 NonReported Work

FRACTION AND TEST CODES FOR WORK NOT REPORTED ELSEWHERE

01C	:	DUP602
02C	:	DUP602
03C	:	DUP602
04C	:	DUP602
05C	:	DUP602
06C	:	DUP602
07C	:	DUP602
08C	:	DUP602
09C	:	DUP602
10C	:	DUP602

CORPORATION

PAGE 1 Analytical Serv REPORT LAB # 84-03-045

RECEIVED: 03/08/84 03/16/84 11:15:24

REPORT TO: Radian / BI 1 / Austin

ATTEN: Debra Eichmann

CLIENT: ENGLAND AFB SAMPLES 1

COMPANY: England AFB

FACILITY:

PREPARED BY: Radian Analytical Services / 8501 MoPac Blvd / P.O. Box 9948 / Austin, Texas 78766

ATTEN:

PHONE: (512) 454-4797

CERTIFIED BY

CONTACT: CONOVER

WORK ID: trip blanks

TAKEN: DLR

TRANS: hand

TYPE:

P.O. #: 212-027-10-05

INVOICE: under separate cover

SAMPLE IDENTIFICATION

01 trip blank

Analytical Serv TEST CODES and NAMES used on this report

GC 602 EPA Method 602/GC

CORPORATION

PAGE 2 Analytical Serv REPORT LAB # 84-03-043
RECEIVED: 03/06/84 Results by Sample

SAMPLE ID trip blank FRACTION 01A TEST CODE GC 602 NAME EPA Method 602/GC
Date & Time Collected not specified Category

DATA FILE D DATE INJECTED 03/14/84 ANALYST MCL VERIFIED BY JSG
CONC. FACTOR INSTRUMENT d COMPOUNDS DETECTED 0

SCAN	COMPOUND	RESULT	SCAN	COMPOUND	RESULT
	Benzene	ND		1,3-Dichlorobenzene	ND
	Toluene	ND		1,2-Dichlorobenzene	ND
	Ethyl Benzene	ND		1,4-Dichlorobenzene	ND

NOTES AND DEFINITIONS FOR THIS REPORT
SCAN = scan number or retention time on chromatogram
All results reported in ug/L unless otherwise specified
ND = not detected at EPA detection limits method 602 (Federal Register 12/3/79)

Analytical Serv REPORT LAB # 84-03-043
RECEIVED: 03/05/84 NonReported Work

FRACTION AND TEST CODES FOR WORK NOT REPORTED ELSEWHERE

01B : DUP602 01C : DUP602 01D : DUP602

APPENDIX G

References

APPENDIX G

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APPENDIX H

Definitions, Nomenclatures and Units

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APPENDIX H

Definitions, Nomenclatures and Units

- AFB - Air Force Base.
- Alluvium - stream-deposited sediment consisting primarily of clay, silt, sand and gravel.
- Aquifer - geologic unit capable of storing and transmitting significant quantities of wtaer.
- C - field conductivity.
- CE - Civil Engineering.
- CFS - cubic feet per second.
- Confined aquifer - an aquifer containing ground water that is under sufficient pressure to rise above the level at which it is encountered by a well.
- DOD - Department of Defense.
- EPA - U.S. Environmental Protection Agency.
- EPA Method 413.2 - IR Method for determining oil and grease concentrations.
- EPA Method 602 - GC Method for determining volatile aromatic hydrocarbon concentrations.
- Extraction - method for mobilizing contaminant species from a solid matrix prior to analysis.
- GC - gas chromatography.
- GPM - gallons per minute.
- H_2SO_4 - sulfuric acid.
- IR - infrared.
- IRP - Installation Restoration Program.
- JP-4 - jet fuel used by Air Force.
- mg/L - Milligrams per liter.

- $\mu g/g$ - micrograms per gram.
- $\mu g/L$ - micrograms per liter.
- $\mu mhos$ - micromhos (a measure of specific conductance).
- MGD - million gallons per day.
- MOGAS - motor gasoline.
- MSL - mean sea level.
- O&G - oil and grease.
- POL - petroleum, oil and lubricants.
- ppb - parts per billion ($\sim\mu g/L$).
- ppm - parts per million ($\sim mg/L$ or $\mu g/g$).
- PVC - polyvinyl chloride.
- QA/QC - Quality Assurance/Quality Control.
- RCRA - The Resource Conservation and Recovery Act.
- Soxhlet - apparatus used in extraction procedure.
- spike - the known amount of a compound added to a sample to determine the precision of analysis.
- TFW - Tactical Fighter Wing.
- USAF - United States Air Force.
- USDA - United States Department of Agriculture.
- USGS - United States Geological Survey.
- water table - the elevation of the ground-water surface in an unconfined aquifer.

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APPENDIX I

Sampling and Analytical Procedures

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Field Procedures

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QUALITY ASSURANCE

The bulk of the field sampling procedures were presented in Section 3.1 of the report. The purpose of this Appendix section is to describe the quality control and quality assurance aspects of the field program in greater detail.

Many of the traditional quality assurance techniques (duplicate or spiked samples, for instance) are dsigned to test instrument or analyst performance and do not address the needs of a field program of monitoring well installation. In lieu of such techniques, field practices are built around a principal of "do it right the first time", and procedures are developed to insure this. The two main elements of the field QA program for Phase II Stage 1 studies at England AFB are:

- o Record-keeping; and
- o Technical staff management review.

Each is discussed below.

Record-Keeping

The supervising geologist kept field notes as the soil boring and sampling activities progressed. These notes were used to develop the lithologic logs in Appendix B. All samples were re-examined at Radian to verify field descriptions.

Ground-water samples were collected in accordance with provisions of the Statement of Work. The servicing laboratory prepared sample containers and provided them to the field team. After the samples were logged into the laboratory, the log-in sheets were compared against the original analytical schedule. All samples were Priority I air-expressed to the laboratory, accompanied by chain-of-custody forms (Appendix D).

Technical Staff Management Review

After the complete report was finalized by the Project Director, it was formally reviewed by a senior member of Radian's technical staff management. This review focused on quality of presentation and soundness of discussion and recommendations.

FIELD EQUIPMENT CALIBRATION

This program utlized very little in the way of field instrumentation. The two main items of equipment were:

- pH meter (Corning Model 610A with a combination electrode), standardized daily against pH 7.00 and 10.00 or 4.00 buffers; and

- Conductivity meter (YSI Model 33), calibrated before deployment against an 800 μmho standard and daily internal calibration check ("red line").

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Laboratory Quality Assurance Program

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Quality Assurance/Quality Control Program for Radian Analytical Services

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THE QUALITY ASSURANCE/QUALITY CONTROL PROGRAM
FOR RADIAN ANALYTICAL SERVICES

Radian Analytical Services' (RAS) objective is to provide high quality chemical analyses to all clients regardless of the size of the analytical task. To aid in achieving this goal, a strong quality assurance program and rigid quality control practices are integral parts of all analyses. This document describes these quality assurance/quality control protocols for the Radian Analytical Services laboratories.

The basic quality control program includes procedures for sample handling, calibration, spiking and replicate analyses, analysis of QC test samples, equipment maintenance, and supplies control. These procedures can be integrated with a client's additional requirements, such as spiking studies, analysis of replicate samples, linearity determinations, and stability studies.

The quality assurance program consists of the frequent submission of blind QA samples, duplicates, and spiked sample splits. Results of these analyses are maintained in the RAS files at the laboratory. Also included are personnel training, analytical methodologies, sample control procedures, data handling, and equipment maintenance and calibrations.

1.0 QA Organization/Policy

The objective of Radian's quality assurance/quality control program is to assure, assess, and document the precision, accuracy, and adequacy of data obtained from chemical analysis and to assure the technical accuracy of the results obtained for all samples.

Radian has organized the quality assurance function within the company to allow complete independence of program review. Radian's Quality Assurance Director reports directly to the Vice President of the Technical Staff. This position provides independent reviews at all levels of the technical staff and laboratory organization and allows immediate access to Radian's top management on QA-related matters.

The QA Director's involvement may be limited to a review of quality control practices or as extensive as active development and implementation of quality control procedures and statistical data analysis. The QA Director may be asked to contribute expertise and assistance when a need is perceived by either the client, the technical staff, or the management staff.

Because of the large number of samples analyzed by RAS, a QA coordinator has been assigned to monitor and maintain an effective QA/QC program for these laboratories. The RAS Quality Assurance Coordinator, directly responsible to the Corporate QA Director, serves as an independent auditor of all RAS laboratories. The responsibilities of the RAS QA Coordinator are as follows:

- Monitor QA/QC within RAS laboratories,
- Supervise the preparation of blind audit samples,

- inform the Director of RAS and the corporate QA Director of quality assurance problems,

- summarize and report QA activities in the laboratories,

- document all QA and QC procedures within RAS,

- act as liaison between the corporate QA Director and RAS,

- provide QA data to the corporate QA Director for inclusion in the corporate QA reports.

The RAS laboratory managers function as the quality control coordinators in each particular analytical area. Their efforts are coordinated and monitored by the QA Coordinator.

Quality control coordinators serve as a focal point for all QC activities pertaining to each RAS laboratory. They work as a committee coordinated by the RAS Quality Assurance Coordinator. Their activities include the following:

- monitor the QA/QC activities of the laboratory area,

- inform the Director of Analytical Services and the QA coordinator of QC problems and needs.

- summarize, document, and report quality control activities and data generated in the laboratory,

- provide documentation of all QC procedures in the laboratory,

- maintains summaries of QC activities and data in a form suitable for client review upon request.

2.0 Quality Control for Laboratory Analyses

Radian Analytical Services has developed and implemented quality control procedures for all of the analyses performed in the laboratory. The laboratory quality control program provides an effective and efficient laboratory protocol for QC regardless of the size or scope of the analytical requirements. Approved analytical methods are used whenever available. When approved methods are not available, a method is developed by the Radian technical staff, and a technical note written describing the method. The quality control procedures are designed to insure that the standard operating procedures and quality control protocols are being followed and accurate results are obtained.

The general quality control program utilized in each laboratory includes consideration of the following areas:

- personnel training and certification,
- analytical methodology documentation,
- sample handling and control,
- laboratory facilities and equipment,
- calibration and standards,
- data handling and documentation,
- quality control check samples,

The general approach to quality control in each of these areas is discussed in the remainder of this section.

2.1 Personnel Training and Certification

The successful implementation of any QA/QC program is determined by the training and dedication of the laboratory personnel. The quality and consistency of data should be independent of the analyst. With the proper training and supervision, an analyst will be able to obtain quality data by the use of proven methodology. Periodic assessment of training requirements and certification are performed to maintain a high level of laboratory awareness.

The training and certification methods employed in the RAS laboratories are briefly described below:

- study of laboratory standard operating procedures,
- study of QA manual,
- observation of experienced operators/analysts,
- study of operating manuals,
- instruction by the laboratory manager on all aspects of the analysis,
- perform the analysis under the direct supervision of the laboratory manager,
- perform analysis under supervision of experienced personnel,
- analysis of blind QC samples prepared by laboratory QC coordinator,
- participation in in-house seminars on laboratory methods and procedures.

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PERSONNEL TRAINING RECORD

Employee ____________________

Employee Number ____________________

Date of Employment ____________________

Laboratory Orientation:

Upon completion of each phase of personnel training the employee and Laboratory Manager will initial and date the step completed.

- The RAS laboratory Standard Operating Procedures have been read and understood.

  ________ ________ ________
  Employee Lab Mgr. Date

- The RAS Quality Assurance manual has been read and the procedures for the laboratory in which the employee worker have been explained.

  ________ ________ ________
  Employee Lab Mgr. Date

- Operation manuals for instruments with which the employee performs analyses have been studied and the procedures for operation and maintenance are understood.

Instrument	Employee	Lab Mgr.	Date	Instrument	Employee	Lab Mgr.	Date

Figure 2-1.

Test Specific Training:

Each specific test performed in the RAS laboratories involves procedures which may be unique. The steps involved in training an employee are:

- Instruction by the Laboratory Manager on all aspects of the analysis,
- Observation of experienced operators/analysts,
- Perform the analysis under supervision of the laboratory manager,
- Perform analysis of QA samples submitted by the QA coordinator, and
- Participation in in-house seminars on laboratory methods and procedures.

The following table is to be completed by dating and initialing by the employee and Laboratory Manager upon completion of each step.

Method	Instruction	Observation	Perform the Analysis	Analysis of QA samples	Seminars

Figure 2-1. (Cont'd)

All RAS personnel must complete a quality control training program. This system includes motivation toward producing data of acceptable quality and involves "practice work" by new employees. New personnel are made aware of the quality standards established by RAS and the reasons for those standards. They are made aware of the various ways of achieving and maintaining quality data. After an employee has been trained to use a method and the work validated by the laboratory manager, the employee is certified to perform the analysis. As these people progress to higher degrees of proficiency, their accomplishments are reviewed and then documented. Documentation of proficiency training is maintained by the QC Coordinator for each laboratory technician using the two-page form shown in Figure 2-1.

2.2 Analytical Methodologies

All analytical procedures followed in the RAS laboratories are documented in a methods manual for the specific laboratory. A set of standard operating procedures (SOP) has been established for each analysis to insure consistency. Most methods used are directly from an approved analytical manual, e.g., EPA methods, APHA Standard Methods for Water and Wastewater, ASTM, etc.

Methodologies may contain the following information:

- method title,
- scope of method,
- summary of interferences, and applications,
- concentration ranges and detection limits,
- safety precautions,
- required equipment and materials,
- standardization directions,
- detailed analytical procedure,
- calculations, with examples,
- reporting method,
- precision and accuracy statement,
- references.

2.3 Sample Control and Record Keeping

The Radian Analytical Services Sample Control Center is a controlled access area. Only employees of the Sample Control Center have access to sample receiving, sample storage, documentation files, and the computer terminals. Analysts check out samples under the supervision of the sample control personnel. All samples are stored in locked storage areas. Sample tracking is maintained by a computerized laboratory management system and a sample checkout logbook. The RAS Sacramento laboratory is linked to the central processing unit of the computer in Austin via a dedicated phone line. This insures that the laboratories are in constant communication. All sample information and data entries can be immediately accessed at either location.

Detailed record keeping and control of samples are essential for effective laboratory operation. All samples received for analysis in the Radian Analytical Service laboratories are processed through the Sample and Analysis Management System (SAM). Radian Corporation's SAM is a software and hardware system for controlling and handling information for the analytical laboratory. SAM provides a dynamic, easy-to-use method for tracking, scheduling, reporting, and laboratory management. The system has been designed to accommodate and promote good laboratory management practices by providing high visibility of the information laboratory managers need to make good decisions regarding schedules and priority. The system is designed around a Data General Nova-IV computer with a 64K-byte memory. It also includes a 65M-byte disk drive and a line printer with plotting capabilities. Data is entered via a TEC terminal and CRT. All data stored on the disk is backed up on magnetic tape to prevent loss in the event of a system malfunction. The system is designed so that an individual designated as the principal operator can process the required paperwork for a large laboratory with little difficulty. The approach centralizes information input and data retrieval, and provides the mechanism for organized, up-to-date laboratory performance monitoring.

SAM maintains complete client information files, generates laboratory status reports, flags sample analyses which are overdue, accepts analysis results manually or automatically, and generates reports and invoices.

The Sample Control Center and SAM have six basic functions:

- sample receipt and logging,
- sample storage and maintenance of sample integrity,
- laboratory status reporting,
- document control,
- data compilation and reporting, and
- invoicing

In order to assure the integrity of a sample and the accompanying documentation, a security plan has been established. This plan consists of three parts:

- chain or custody,
- secured refrigerated storage, and
- document control.

The progression of samples and documentation through the Sample Control Center and the analytical laboratories is presented in Figure 2-2. Detailed descriptions of each sample control function are presented below:

- Samples are received from the commercial carrier at Radian's shipping and receiving facilities by the receiving clerk.

- Within one hour of arrival, the samples are accepted by RAS sample control personnel.

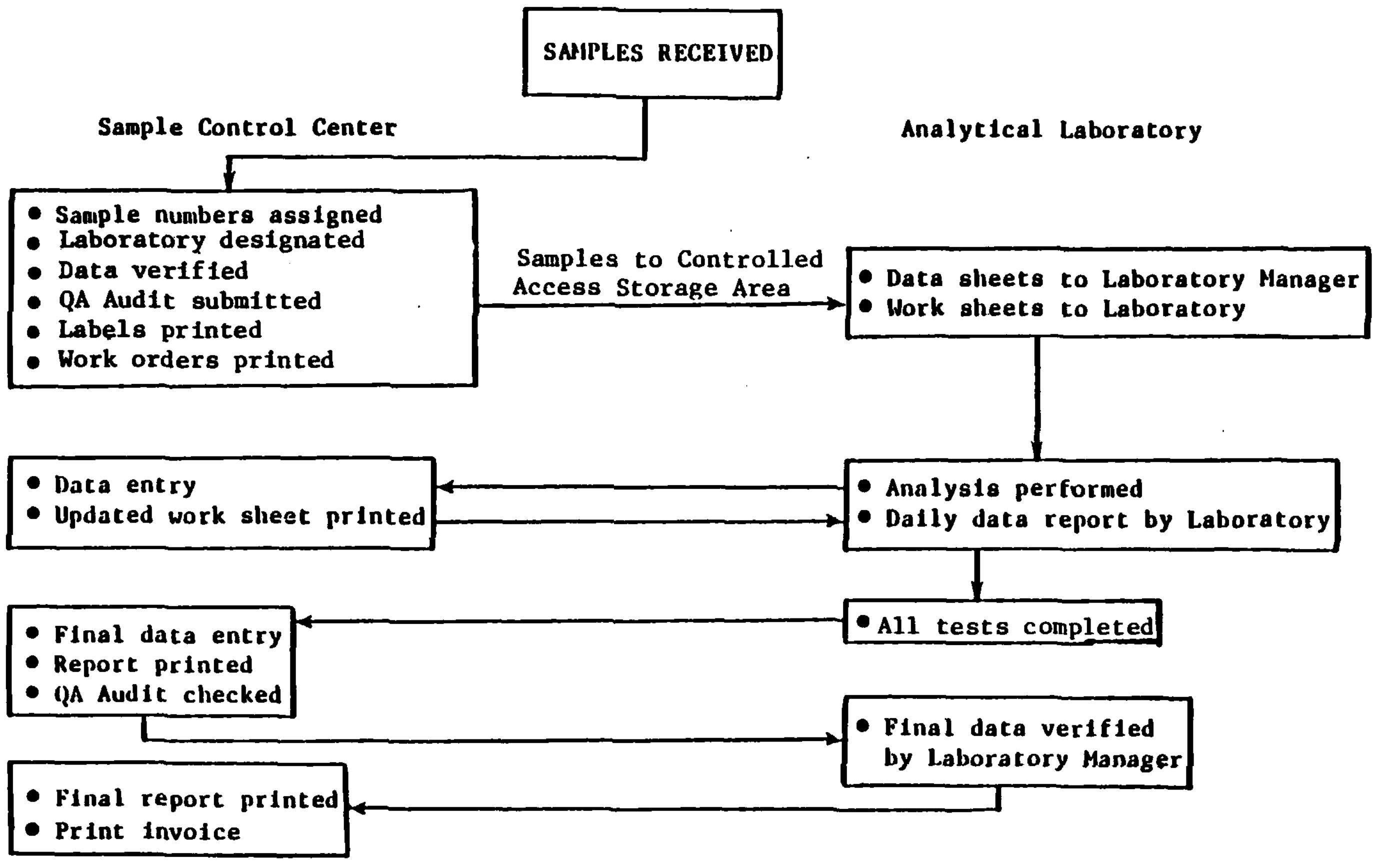

Figure 2-2. SAM Laboratory Management System

- All shipping containers and security seals, when appropriate, are inspected for physical damage or evidence of tampering.

- The samples are unpacked in the sample receiving area by the RAS sample custodian. The method of shipment, shipping container integrity, condition of samples, the number of samples/container, integrity of the security seal, and accompanying documentation are noted. Sample identification is verified against custody documents. The enclosed chain-of-custody forms, Figure 2-3, when required, are completed and filed with the shipping and receiving documentation. In the event that peculiarities are noted, the project officer or client is immediately advised of the irregularity.

- Samples are logged into a bound sample logbook, Figure 2-4. Again, sample identity is verified. All discrepancies are noted in the logbook.

- The handwritten logbook and all documentation are transferred to the Sample Control Center.

- The samples are logged into the SAM system. Each batch of samples is assigned a consecutive work order number by the system. Analytical requirements for each sample are entered into the computer.

- Hard copy of the work order and other information is printed and filed with the received documentation in the Sample Control Center.

- Labels are printed and secured to each sample. Label information includes sample number, identification, storage location, and analytical requirements.

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CHAIN OF CUSTODY RECORD

Field Sample No. ____________

Company Sampled/Address ____________
Sample Point Description ____________

Stream Characteristics:
Temperature ____________ Flow ____________ pH ____________
Visual Observations/Comments ____________
____

Collector's Name ____________ Date/Time Sampled ____________
Amount of Sample Collected ____________
Sample Description ____________
Store at: ☐ Ambient ☐ 5°C ☐ −10°C ☐ Other ____________

☐ *Caution - No more sample available* ☐ *Return unused portion of sample* ☐ Discard unused portions

Other Instructions - Special Handling - Hazards ____________
____
____

☐ Hazardous sample (see below) ☐ Non-hazardous sample

☐ Toxic	☐ Skin irritant	☐ Flammable (FP< 40°C)
☐ *Pyrophoric*	☐ *Lachrymator*	☐ Shock sensitive
☐ Acidic	☐ Biological	☐ Carcinogenic - suspect
☐ Caustic	☐ Peroxide	☐ Radioactive

☐ Other ____________

Sample Allocation/Chain of Possession:
Organization Name ____________
Received By ____________ Date Received ____________ Time ____________
Transported By ____________ Lab Sample No. ____________
Comments ____________
Inclusive Dates of Possession ____________

Organization Name ____________
Received By ____________ Date Received ____________ Time ____________
Transported By ____________ Lab Sample No. ____________
Comments ____________
Inclusive Dates of Possession ____________

Organization Name ____________
Received By ____________ Date Received ____________ Time ____________
Transported By ____________ Lab Sample No. ____________
Comments ____________
Inclusive Dates of Possession ____________

Figure 2-3. Chain or Custody Record

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Lab No. ________

Company ________
Facility ________
____
Rep ________
Phone ________
Report ________
to ________
____
____
Attn ________
Inv ________
to ________
____
____
Attn ________
P.O. # ________
Expires ________

Quoted $ ________
Sample $ ________
Misc $ ________
Total $ ________
Inv by (CPR) ________
% Surcharge ________
% Disc: All ________

Contact ________
Received ________
Date Due ________
Samples ________
Keep for ________
Keep til ________
Disp (RD) ________

Reports ________ # Invoices ________

Work ID ________
Taken ________
Trans ________
Type ________
Condition ________
Comments:

Location: ________

Dash No.	Sample Description	Analysis Required	QA

Figure 2-4. Sample Log Sheet

- Data sheets and work sheets are printed for each batch of samples and distributed to the appropriate laboratory managers. The work sheets list sample numbers, sample identification, storage location, and analytical requirements. Data sheets are for results and contain only the parameters to be determined by a given laboratory.

- Following sample logging, the samples are placed in the designated locked storage area.

- Subsequent sample custody is documented and all transactions witnessed by sample control personnel.

- The analyst retrieves the samples from the Sample Control Center by sample number and storage location.

- The Sample checkout log (Figure 2-5) is completed by the analyst, noting the laboratory to which the sample is being removed.

- After analysis, or when the required aliquot is removed, the sample is returned to the Sample Control Center and return is noted in the sample checkout log.

- The sample is returned to the designated storage location.

- When requested, addition chain-of-custody documentation can be provided using a SAM-generated document (Figure 2-6). This document can be retained by sample control to provide a more easily retrievable record of sample custody within the analytical laboratory.

- The sample is stored until the assigned time or written permission is given to either properly dispose of or return the sample to the client.

RAS SAMPLE CHECK OUT LOG

WORK ORDER	SPLITS REMOVED	CHECK-OUT INFORMATION				RETURN INFORMATION			
		DATE	TIME	DESTINATION	INITIALS	DATE	TIME	INITIALS	
									7S/196 (Water and Prep. Labs)
									7S/194 (Extraction & Water Labs)
									7S/180 (ICP and AA Labs)
									7S/191 (TOX, TOC)
									7S/195 (Technician)
									7S/171 (GC)

Figure 2-5. Sample Checkout Log

PAGE 1 CORPORATION Analytical Serv CHAIN OF CUSTODY LAB # 83-02-A67

RCVD: 02/26/83 DUE: 03/19/83 04/21/83 09:56:49 KEEP: 05/09/83 DISP: D

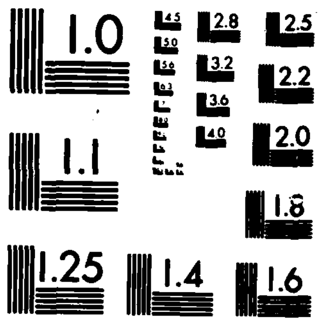
DASH	SAMPLE IDENTIFICATION	LOCATION	TESTS						
01A-B	Number 001	Ref 2	CAUSTY	CO3_A	HARD_B	HCO3_A	MHO_A	ONG_A	PH_A
			PO4_B	SO3_TA	TANNIN				
02A	Number 002	Ref 2	ACFS						
02B	Number 002	Ref 2	ICP_40						
03A	Super soil	Ref 2	ANFS						
04A	Boiler scale 222	Ref 2	CA_E	CL_TA	CO3_A	FE_E	HCO3_A	MG_E	NA_E
			P_E	SO4_NA	S_E	ZN_E			
05A	Sample AV56	Shelf 13	B_MET	C_MET					
06A	Water #164	Ref. 023	AG_E	AS_HA	BA_E	CD_E	CR_E	FE_E	HG_CA
			MN_E	NA_E	PB_GA	SE_HA			
06B	Water #164	Ref. 023	CL_TA	F_SIEA	MHO_A	NO3_A	PH_A	SO4_NA	TDS_A
06C	Water #164	Ref. 023	H1RCRA	P1RCRA					
06D	Water #164	Ref. 023	ALPHA	BETA	RA_TOT				

RECEIVED BY	DATE	RETURNED TO	DATE	FRACTION NUMBERS.

Figure 2-6. Laboratory Chain of Custody

AD-A165 044 INSTALLATION RESTORATION PROGRAM PHASE II 3/3
CONFIRMATION/QUALIFICATION STAGE 1 FOR ENGLAND AFB
LOUISIANA(U) RADIAN CORP AUSTIN TX G D SWOBODA NOV 85
UNCLASSIFIED RAD-212-027-10 F/G 13/2 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

- All documentation, including shipping documents, field sampling documents, computer-generated log sheets, chain-of-custody forms, laboratory data sheets, final computer reports, and other documents, are maintained in the sample control area. All reports are kept in locked filing cabinets. As with the sample storage area, the document storage area is limited-access.

All storage areas are within the Sample Control Center and are locked when not in use. Access to the storage area is limited to sample control personnel or other RAS employees accompanied by sample control personnel. There are four storage locations that are used depending on the sample and the required analyses. They are:

- ambient storage for samples that do not require refrigeration,

- 4°C storage for most samples requiring water quality analysis and extractable organics,

- 4°C storage for samples requiring volatile organic analysis, and

- -20°C storage for extracts and samples that require freezing.

A temperature log is maintained to monitor the cold storage facilities.

2.4 Laboratory Facilities and Equipment

A clean well-lighted, and well maintained laboratory is essential for accurate analytical results. Each laboratory is well-lighted, air conditioned and equipped with chemical fume hoods. Instrumentation that may emit noxious odors is vented externally.

Quality Control of Equipment and Supplies

Each laboratory QC program includes detailed requirements for equipment and supplies. Reagents, solvents, and standards with specific levels of purity are used as specified by the analytical protocol. Specific GC column materials, glassware and sample handling equipment are also specified. The quality control procedures for equipment and supplies generally include the following items:

- operator checklists for required supplies,
- documentation and reporting of all deviations from specified instrument performance,
- procedures for testing for purity of reagents,
- tolerances for calibrated glassware where applicable,
- monitoring of refrigerated storage space,
- maintenance logbooks,
- service contracts on analytical instrumentation.

Quality control procedures during sample preparation include the preparation of reagent or solvent blanks. Additional quality control techniques implemented in sample preparation include:

- deionized water piped into all laboratories, monitored daily,
- purchasing high purity distilled-in-glass solvents in large quantities from a single lot,

- use of Ultrex acids in trace metal digestion,
- cleaning of organic glassware with chromic acid or firing in a kiln at 450°C,
- cleaning of trace metal glassware with nitric acid,
- use of organic-free water prepared at Radian by distillation over alkaline permanganate under nitrogen atomsphere in all-glass still,
- use of volatile-free water prepared by purging organic-free water with nitrogen,
- sample preparation performed by experienced technical personnel under the supervision of senior level analysts.

2.5 Quality Control for Standards and Calibration

The quality of all test results is greatly impacted by the calibration procedures used. Calibration procedures and standards should be specified for all equipment and supplies used in the test procedure. Traceability to common standards is essential for test procedures to be used in multiple laboratories. Quality control procedures for standards and calibrations include the following considerations:

- written, detailed calibration instructions,
- preparation procedures for secondary standards, when applicable,
- requirements for frequency of calibration,
- recordkeeping of all calibrations and standards used,

- quality control charts for recording results from multiple calibrations,

- evaluation of internal standards, and

- tolerances for calibration requirements.

All calibration standards are prepared from NBS-traceable, EPA certified, or primary standard materials. Daily logs are maintained to monitor instrument response to a given standard.

Quality Control Test Samples

Routine quality control samples to be analyzed concurrently with client samples are a significant portion of the RAS laboratory quality control programs. The purpose of these checks is twofold: 1) to assure that samples being analyzed satisfy predetermined standards of accuracy, and 2) to measure and document achieved levels of accuracy and precision.

There are many different types of quality control samples which could be used for these purposes. The correct combination of these will depend on the complexity of the test method and the desired degree of accuracy. The following quality control parameters are general considerations for Radian's quality control for test methods.

Interferences

The analytical results of a test method might be affected by interferences from the glassware, solvents, reagents, or the sample matrix. Blank samples which are subjected to conditions similar to samples being analyzed are used to evaluate the purity of laboratory reagents. The frequency of blank analysis is method dependent. For example, a laboratory or field blank is analyzed after each GC/MS volatile organic analysis with high levels for any of the pollutants. Ten percent of the samples from a

given sample batch are spiked with a known standard. Spike recovery data are calculated to determine matrix interference.

Precision

The precision or repeatability of a test method is required for proper interpretation and weighting of the data. Replicate samples or standards are used to determine the precision on a regular basis. The precision of multiple analyses are compared against predetermined precision limits to determine their acceptability. The precision is usually reported as a standard deviation or repeatability statistic and often depends on the concentration of the parameters analyzed. Replicate analyses are defined as separate digestions or extractions of the same sample, when possible. The percentage difference or range between replicate analyses is also used to monitor precision.

Reproducibility

The reproducibility of a test method refers to the repeatability over a period of time. How well will analytical results repeated a month later agree with today's results? Reproducibility can be measured by the repeated analysis of samples from a previous time period or by analysis by more than one laboratory or laboratory technician.

Qualitative Specificity

In the analysis of complex sample matrices containing multiple components, the use of a single method can lead to misidentification of compounds. The misidentification can be detected by repeated analysis of standards containing the compounds of interest or by independent analysis by a more specific method. For example, mass spectral confirmation can be used to evaluate misidentification problems in the GC laboratory.

2.6 Documentation and Data Handling

Documentation of methods, procedures, and results is an essential aspect of a QA/QC program.

Adequate documentation is required for an instrument maintenance system. RAS laboratories use an individual logbook, which is kept at each instrument, to record all calibration and maintenance activities. This logbook gives a chronology of that instrument's installation, operation, calibrations, maintenance, malfunction, and repairs. An accompanying binder includes all pertinent manufacturing information, service manuals, and similar reference materials.

Directions for calibrations and maintenance, along with appropriate forms and checklists, are maintained in a manual accompanying the logbook. The directions specify the required frequency for calibrations and maintenance, the tolerances for calibrations, and the action to be taken when calibration requirements are not met.

In this system, there is a single source for reference purposes as well as record keeping. All the instrument logbooks are reviewed periodically by the quality assurance coordinator and laboratory manager. A record of these logbook checks is maintained by the QA coordinator.

Work sheets have been developed to insure consistent laboratory data entry for most parameters determined in the laboratories. These sheets are designed to organize the data in a clear and logical manner, and to simplify calculations. The work sheets are divided into various sections including a section for reporting calibration standards and blank values and a section for plotting calibration curves. These work sheets are usually a standard data entry form which the laboratory technician enters in his/her bound lab notebook. When automated calibration is not applicable, electronic calculators are available in the laboratories to generate calibration curves by the method of least squates. Thus errors in reading calibration curves and calculating data are minimized. After an analysis

is completed and a data sheet filled out, the laboratory manager checks the data for completeness and approves the data sheet. After the data have been entered into the SAM system, an updated data sheet is issued to the laboratory manager. When the work is complete, a preliminary report is printed and distributed to the contributing laboratory managers for the final data check and approval. A final report is printed, certified by the laboratory manager, and forwarded to the client.

Proper documentation of quality assurance and quality control activities is an essential requirement. Documentation is needed to demonstrate that quality control activities were completed as scheduled and to communicate the results of the QC tests to laboratory managers and clients. Documentation of QA results is required to provide feedback for improvement of quality control programs.

Quality control documentation should be timely in order for feedback to occur. Daily reporting to laboratory managers is mandatory. Forms are designed to organize the QC data in a clear and logical manner, and to simplify calculations. Control charts are another excellent tool for summarizing quality control test results.

As part of Radian's QA audit program weekly reports summarizing audit results in the laboratories are prepared and distributed to QC coordinators.

3.0 Quality Assurance Audits

The quality assurance audit program of the RAS laboratories is conducted by the RAS QA Coordinator in conjunction with the corporate QA Director. The program consists of the following:

- QA standards are prepared using EPA certified standards, NBS standards, primary standard materials, and NBS-traceable compounds. All standards preparations are recorded in the QA Sample logbook (Figure 3-1).

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Standard No. QAS ____________

QA type ______________________

Prep date ____________ Prepared by ______________ Verified by ____________

Standard source ____

____

Sample matrix ____

Parameters

Preparation method   Final vol ____________

Figure 3-1. Standards preparation logbook

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QAS ______________

Prep method (con't)

Calculations

Sample Distribution

Date	SAM No.	Client	Remarks

Figure 3-1. (Cont.)

- An inventory of stock standards is maintained within the limits of published stability data. This decreases the time required for daily standard preparation.

- Duplicate samples are requested from clients. These are blind to the laboratory and the client is not billed for the duplicate.

- Blind QA samples are submitted through the Sample Control Center to all laboratories. The parameters and concentration levels are selected by the RAS Quality Assurance Coordinator.

- Laboratory managers submit, via a "QA Alert Form" (Figure 3-2). a list of the types of QA samples needed the following week. This insures that the parameters with which there have been problems are included in the sample.

- Monthly reports are issued from the RAS QA Coordinator (Fig. 3-3). These are submitted to the corporate QA Director, laboratory managers and Director of RAS. Managers are notified immediately of major problems with the results of analysis of a QA sample.

- The results of the program are summarized on a quarterly basis for Radian's management.

In addition to the continuous audit program, provisions for third party review are made with each client's work. Radian Analytical Services welcomes onsite audits, performance samples, and independent evaluations.

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QA ALERT FORM

QA standard for the week of ____________

NPDES
Form A water __
Form B water __
metals __
Form C water __
metals __
organics __

RCRA metals __
anions __

pesticide
OC __ OP __
herbicide __

EPA 601 __
602 __
624 __
625 __

B/N __ Acids __ A/N __

TOC __ TOX __

MS VOA __ GC VOA __

PCB __

Matrix requirements: ______________________________

Concentration requirements: ______________________________

Special Standards/Instructions	Individual Parameters

Date ______________ Mgr ______________________

Figure 3-2. QA alert form

ANALYTICAL SERVICES
MONTHLY QA REPORT

QA prep report for the month of ____________

Order No.	Lab	Parameter	Certified Value	Analyzed Value	% Recovery	Date Reported

Figure 3-3. Monthly QA Report

3.1 Data Review and Validation

All analysis results are entered into the SAM computer system. Following completion of the analyses, a preliminary report is printed and returned to the appropriate laboratory manager for review and validation. A final report is printed after the certification by the manager. This report is signed and approved by the laboratory manager before being forwarded to the client. The following diagram (Fig. 3-4) illustrates the data flow for a typical sample analysis.

Upon completion of the analysis and before the final data are issued, the results of the QA audit samples are compared to the certified values. These results are plotted on control charts. Separate control charts are maintained for each analysis. If results are outside the accepted control limits, the analytical results are held until the problem is resolved.

3.2 Control Charts

Quality control charts are maintained for both accuracy and precision. Both charts are structured as shown in Figure 3-5. The main portions of the chart are the center line and the two control limits. The center line is the 100% or total recovery/total agreement of analytical results. The upper and lower control limits are calculated from historical data.

Control charts for accuracy are constructed as follows:

Precent recovery of standards (P_{ST}):

$$P_{ST} = 100 \times \frac{\text{analyzed value}}{\text{certified value}}$$

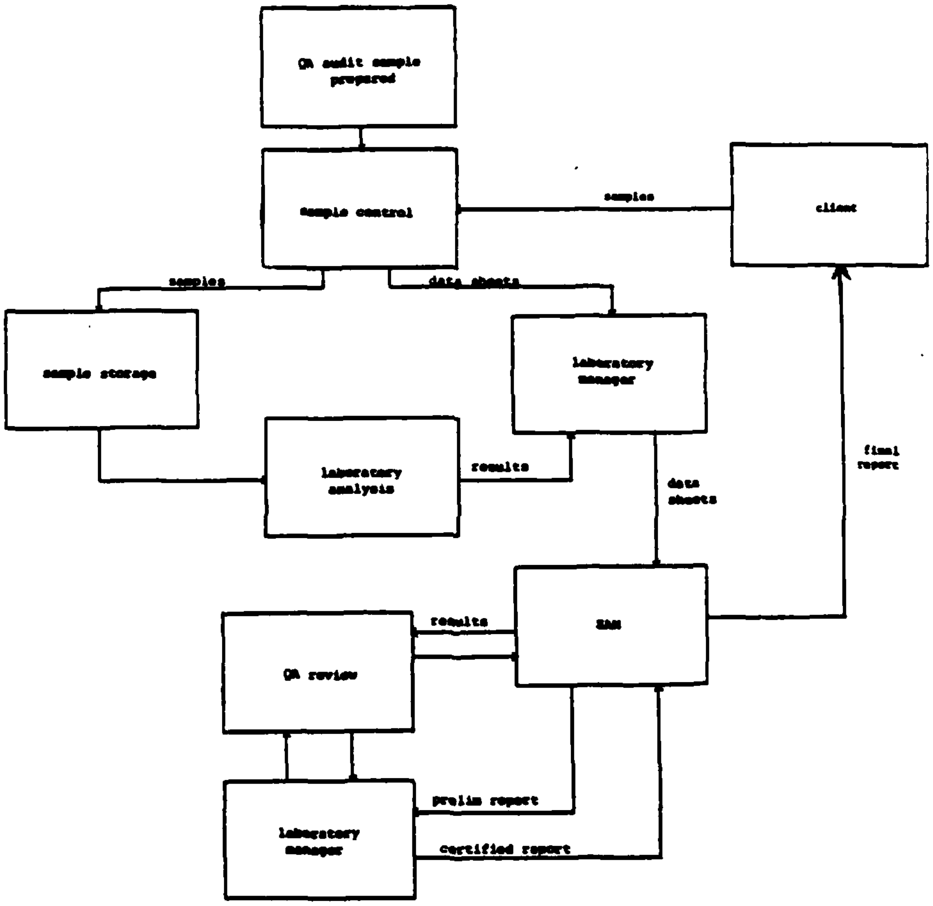

Figure 3-4. Data Flow

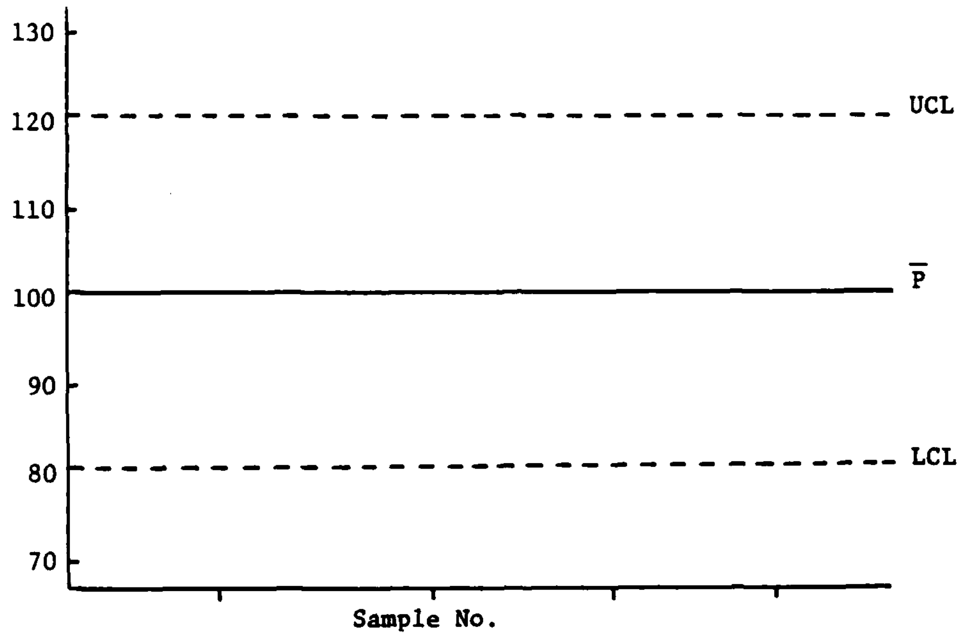

Figure 3-5. Control Chart

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Percent recovery of spikes in samples (P_{SP}):

$$P_{SP} = 100 \times \frac{\text{analyzed value - background value}}{\text{spike}}$$

From a set of analyses, the average percent recovery ($\overline{P}$):

$$\overline{P} = \frac{\sum_{i=1}^{n} P_i}{n}$$

The standard deviation for percent recovery (S_R):

$$S_R = \sqrt{\frac{\sum_{i=1}^{n} P_i^2 - \left(\sum_{i=1}^{n} P_i\right)^2 / n}{n-1}}$$

The upper and lower control limits are therefore

$$UCL = \overline{P} + 3S_R$$
$$LCL = \overline{P} - 3S_R$$

An analysis is out of control when either of the two conditions apply:

1) Any results outside the control limits
2) Seven successive results on the same side of the control line.

Control charts for precision are also constructed. Precision is a function of the concentration range of the analyte. The closer the result is to the analytical detection limit, the more imprecise the data become on a percentage scale. Figure 3-6 illustrates the relationship between detection limit and precision for a typical methodology. Because of this concentration dependence, precision control charts need to be developed for specific concentration ranges for each analyte. For duplicate samples A and B, the ratio of the values of A and B are plotted.

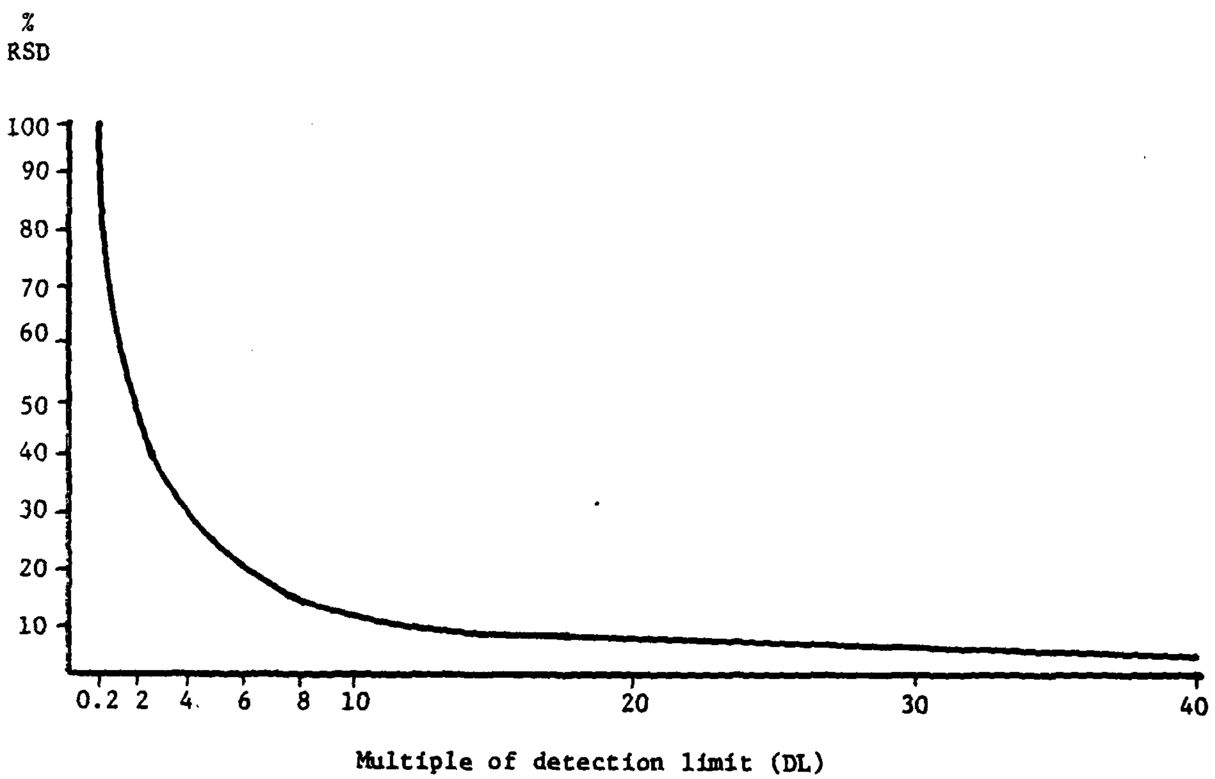

Figure 3-6. Relationship between Detection Limit and Precision

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3.3 Concurrent Review

Upon review of analytical results of QA audit samples, the QA Coordinator will schedule a meeting with the laboratory manager if there are any tests out of control or which are deviant from an expected precision/accuracy norm. The purpose of this meeting is to:

- review raw data and determine if there is an explanation for the deviance.
- outline analyses of quality control and/or quality assurance samples to further define the problem and its solution.
- establish a schedule for monitoring the analysis after a solution is implemented, to assure that the problem does not recur.

Involvement of the laboratory manager in the problem assessment and solution is essential to a mutual committment to a quality analytical laboratory.

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APPENDIX J

Sampling Schedule, England AFB, Louisiana

APPENDIX J. SAMPLING SCHEDULE, ENGLAND AFB, LOUISIANA

Sample ID	Sample Type	Sample Depth Interval	Date Collected	Date Delivered to RAS	Analytical Parameter(s)***
D-15 A-1	Soil	S*	3/1/84	3/6/84	O&G
D-15 A-2	"	18"-30"	"	"	"
D-15 A-3	"	54"-66"	"	"	"
D-15 B-1	"	S	"	"	"
D-15 B-2	"	18"-30"	"	"	"
D-15 B-3	"	54"-66"	"	"	"
D-15 C-1	"	S	"	"	"
D-15 C-2	"	18"-30"	"	"	"
D-15 C-3	"	54"-66"	"	"	"
D-15 D-1	"	S	"	"	"
D-15 D-2	"	18"-30"	"	"	"
D-15 D-3a	"	54"-66"	"	"	"
D-15 D-3b	"	54"-66"	"	"	"
D-15 E-1	"	S	"	"	"
D-15 E-2	"	18"-30"	"	"	"
D-15 E-3	"	54"-66"	"	"	"
D-15 F-1	"	S	"	"	"
D-15 F-2	"	18"-30"	"	"	"
D-15 F-3	"	54"-66"	"	"	"
D-15 G-1	"	S	"	"	"
D-15 G-2	"	18"-30"	"	"	"
D-15 G-3	"	54"-66"	"	"	"
D-15 G	Ground water	66"**	3/4/84	"	O&G/EPA 602/T/pH/C

(Continued)

*S = surface.
** = ground-water sample depth is reported as well depth.
*** O&G = Oil and Grease (IR); EPA Method 413.2.
EPA 602 = Volatile Aromatic Hydrocarbons.
T = Temperature.
C = Field Conductivity.

APPENDIX J. (Continued)

Sample ID	Sample Type	Sample Depth Interval	Date Collected	Date Delivered to RAS	Analytical Parameter(s)
D-15 H-1	Soil	S	3/1/84	"	O&G
D-15 H-2	"	18"-30"	"	"	"
D-15 H-3	"	54"-66"	"	"	"
D-15 I-1	"	S	3/1/84	3/6/84	O&G
D-15 I-2	"	18"-30"	"	"	"
D-15 I-3	"	54"-66"	"	"	"
D-15 J-1	"	S	"	"	"
D-15 J-2	"	18"-30"	"	"	"
D-15 K-1	"	S	"	"	"
D-15 K-2a	"	18"-30"	"	"	"
D-15 K-2b	"	18"-30"	"	"	"
D-15 K-3	"	54"-66"	"	"	"
FT-1 A-1	"	S	2/29/84	"	"
FT-1 A-2	"	18"-30"	"	"	"
FT-1 A-3	"	54"-66"	"	"	"
FT-1 B-1	"	S	"	"	"
FT-1 B-2	"	18"-30"	"	"	"
FT-1 C-1	"	S	"	"	"
FT-1 C-2	"	18"-30"	"	"	"
FT-1 D-1	"	S	"	"	"
FT-1 D-2	"	18"-30"	"	"	"
FT-1 D-3a	"	54"-66"	"	"	"
FT-1 D-3b	"	54"-66"	"	"	"
FT-1 D	Ground water	66"	3/3/84	"	O&G/EPA 602/T/pH/C

(Continued)

APPENDIX J. (Continued)

Sample ID	Sample Type	Sample Depth Interval	Date Collected	Date Delivered to RAS	Analytical Parameter(s)
FT-1 E-1	Soil	S	2/29/84	"	O&G
FT-1 E-2	"	18"-30"	"	"	"
FT-1 F-1	"	S	"	"	"
FT-1 F-2a	"	18"-30"	"	"	"
FT-1 F-2b	"	18"-30"	"	"	"
FT-1 G-1	"	S	2/29/84	3/6/84	O&G
FT-1 G-2	"	18"-30"	"	"	"
FT-1 H-1	"	S	"	"	"
FT-1 H-2	"	18"-30"	"	"	"
FT-1 I-1	"	S	"	"	"
FT-1 I-2	"	18"-30"	"	"	"
SP-3 A-1	"	S	3/2/84	"	"
SP-3 A-2	"	18"-30"	"	"	"
SP-3 A-3	"	54"-66"	"	"	"
SP-3 A	Ground water	66"	3/4/84	"	O&G/EPA 602/T/pH/C
SP-3 B-1	Soil	S	3/2/84	"	O&G
SP-3 B-2	"	18"-30"	"	"	"
SP-3 C-1	"	S	"	"	"
SP-3 C-2	"	18"-30"	"	"	"
SP-3 D-1	"	S	"	"	"
SP-3 D-2	"	18"-30"	"	"	"
SP-4 A-1	"	S	"	"	"
SP-4 A-2	"	18"-30"	"	"	"
SP-4 A	Ground water	30"	3/4/84	"	O&G/EPA 602/T/pH/C
SP-4 B-1	Soil	S	3/2/84	"	O&G
SP-4 B-2	"	18"-30"	"	"	"

(Continued)

APPENDIX J. (Continued)

Sample ID	Sample Type	Depth Interval	Date Collected	Date Delivered to RAS	Analytical Parameter(s)
SP-5 A-1	Soil	S	"	"	"
SP-5 A-2	"	18"-30"	"	"	"
SP-5 A	Ground water	30"	3/3/84	3/6/84	O&G/EPA 602/T/pH/C
SP-5 A-3	Soil	54"-66"	3/2/84	"	O&G
SP-6 A-1	"	S	2/29/84	"	"
SP-6 A-2	"	18"-30"	"	"	"
SP-6 A-3	"	45"-57"	3/3/84	"	"
SP-6 A-4	"	84"-96"	"	"	"
SP-6 A-5	"	114"-126"	"	"	"
SP-6 A	Ground water	126"	3/4/84	"	O&G/EPA 602/T/pH/C
SP-6 B-1	Soil	S	3/3/84	"	O&G
SP-6 B-2	"	18"-30"	"	"	"
SP-6 B-3	"	54"-66"	"	"	"
SP-7 A-1	"	S	3/2/84	"	"
SP-7 A-2	"	18"-30"	"	"	"
SP-7 A-3	"	54"-66"	"	"	"
SP-7 A-4	"	84"-96"	"	"	"
SP-7 A-5	"	114"-126"	"	"	"
SP-7 B-1	"	S	"	"	"
SP-7 B-2	"	18"-30"	"	"	"
SP-7 B-3	"	54"-66"	"	"	"
SP-7 B-4	"	84"-96"	"	"	"
SP-7 B	Ground water	96"	3/4/84	"	O&G/EPA 602/T/pH/C

(Continued)

RADIAN
CORPORATION

APPENDIX J. (Continued)

Sample ID	Sample Type	Sample Depth Interval	Date Collected	Date Delivered to RAS	Analytical Parameter(s)
SP-7 C-1	Soil	S	3/2/84	"	O&G
SP-7 C-2	"	18"-30"	"	"	"
SP-7 C-3	"	54"-66"	"	"	"
SP-7 D-1	"	S	"	"	"
SP-7 D-2	"	18"-30"	"	"	"
SP-7 D-3	"	54"-66"	"	"	"
SP-7 D-4	"	76"-88"	"	"	"
R-1146	Ground water	unknown	3/4/84	"	O&G/EPA 602/T/pH/C
R-1147	"	"	"	"	" " " " "
R-1148	"	"	"	"	" " " " "

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APPENDIX K

Summary of EPA Method 413.2 (Oil and Grease) Analysis of Soils After 12-hr Soxhlet Extraction

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APPENDIX K

Summary of EPA Method 413.2 (Oil and Grease)
Analysis of Soils After 12-hr Soxhlet Extraction

Sample No.		Depth	Oil and Grease Concentration
FT-1	B-2	2.5'	2300 μg/g
FT-1	C-1	Surface (S)	8000 μg/g
FT-1	D-3a	5.0'	3000 μg/g
FT-1	D-3b	5.0'	1800 μg/g
FT-1	F-2a	2.5'	2200 μg/g
FT-1	F-2b	2.5'	1500 μg/g
FT-1	G-1	S	1900 μg/g
FT-1	H-2	2.5'	3500 μg/g
D-15	A-3	5.0'	9800 μg/g
D-15	D-2	2.5'	7250 μg/g
D-15	D-3a	5.0'	1500 μg/g
D-15	G-1	S	3600 μg/g
D-15	G-2	2.5'	1150 μg/g
D-15	G-3	5.0'	1800 μg/g
D-15	H-1	S	1500 μg/g
D-15	H-2	2.5'	1800 μg/g
D-15	I-1	S	1900 μg/g
D-15	I-2	2.5'	1500 μg/g
D-15	I-3	5.0'	1400 μg/g
D-15	J-1	S	1100 μg/g
D-15	J-2	2.5'	1300 μg/g
D-15	K-2a	2.5'	5800 μg/g

(Continued)

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APPENDIX K (Continued)

Summary of EPA Method 413.2 (Oil and Grease)

Analysis of Soils After 12-hr Soxhlet Extraction

Sample No.	Depth	Oil and Grease Concentration
SP-3 A-2	2.5'	5100 μg/g
SP-3 B-1	S	1500 μg/g
SP-3 B-2	2.5'	3800 μg/g
SP-3 C-2	2.5'	3800 μg/g
SP-3 D-1	S	3800 μg/g
SP-4 A-1	S	2000 μg/g
SP-4 A-2	2.5'	3000 μg/g
SP-4 B-1	S	2000 μg/g
Sp-4 B-2	2.5'	2500 μg/g
SP-5 A-1	S	2000 μg/g
SP-5 A-2	2.5'	2000 μg/g
SP-5 A-3	5.0'	2000 μg/g
SP-6 A-1	S	4.9/%
SP-6 A-2	2.5'	4800 μg/g
SP-6 A-3	5.0'	1250 μg/g
SP-6 A-5	10.0'	2000 μg/g
SP-6 B-1	S	2.0%
SP-6 B-2	2.5'	7800 μg/g
SP-6 B-3	5.0'	8900 μg/g
SP-7 A-2	2.5'	8500 μg/g
SP-7 A-4	7.5'	2600 μg/g
SP-7 B-2	2.5'	1500 μg/g
SP-7 B-3	5.0'	1300 μg/g
SP-7 B-4	7.5'	5800 μg/g
SP-7 D-1	S	9900 μg/g